Radar Boot Camp 2024: Speaker Bio's and Outlines

Organizing Committee

Hilton Denver City Center Hotel

May 4-5th 2024

Christ Richmond: Opening Ceremony

- **Christ D. Richmond** is a Professor in the Department of Electrical and Computer Engineering at Duke University where he directs the Signals, Information, Inference, and Learning (SIIL) Group. His research interests include statistical signal and array processing, detection and parameter estimation theory, information theory, machine/deep learning, radar/sonar, communications, and spectral sharing. Prior to joining Duke, he was an Associate Professor in the School of Electrical, Computer, and Energy Engineering at Arizona State University, and prior to that Senior Staff in the Advanced Sensor Techniques Group at the MIT Lincoln Laboratory, and a Visiting Lecturer and Associate of the John A. Paulson School of Engineering and Applied Sciences at Harvard University. Prof. Richmond received the Ph.D. degree in electrical engineering from MIT. He is the recipient of the Office of Naval Research Graduate Fellowship Award, the Alan Berman Research Publications Award, and the IEEE Signal Processing Society Young Author Best Paper Award in the area of Sensor Array and Multichannel (SAM) Signal Processing, and he is a Fellow of the IEEE. He has served as the Technical Chairman of the Adaptive Sensor Array Processing Workshop at MIT Lincoln Laboratory and served as a member of the IEEE Technical Committee on SAM Signal Processing. He served as an Associate Editor for the IEEE Transactions on Signal Processing, as a Senior Associate Editor for IEEE Signal Processing Letters (SPL), and currently serves as Editor-in-Chief for IEEE SPL, and as a member of the IEEE Aerospace and Electronics Systems Society (AESS) Radar Systems Panel.

- **Syllabus**

  - **Welcome to the Radar Boot Camp**

Alfonso Farina: History of Radar

- **Dr. Alfonso Farina** joined Selenia (subsequently renamed as "Selex Sistemi Integrati" and then "Selex ES") in 1974 as part of the Leonardo Finmeccanica group. Throughout the following decades, he became a world-leading expert in radar and C2 system design, signal, data & image processing, data fusion, and large systems for civilian as well as defense applications. Nevertheless, from 1979 to 1985, he was also Professor of Radar Techniques at the University of Naples Federico II, Naples, Italy. Accordingly, his precious academic and industrial experience jointly with his creative talent were the keystone for the development of innovative algorithms and related digital-based signal processors applied to modern operative radar systems.

- In relation to the Radar and Sensors Academy activities, he has organized and supervised - from October 2021 to February 2022 - Basic, Intermediate, and Advanced Courses on Radar and EO/IRST including 2800 hours of training for 140 attendees from 12 sites of the Company with 38 lecturers and 15 professors from academia.

- Interestingly, as President of the Radar and Sensors Academy he has interviewed Princess Elettra Marconi, the daughter of Nobel Laureate Guglielmo Marconi, recollecting a number of legacy anectodes and profound reflections on modern radar systems. Remarkably, he was one of the few top managers to be interviewed at RAI Storia (National TV channel) on October 26, 2018 for the 70th anniversary of Leonardo Company.

- **Introduction: purpose and structure**

- **Origins (explained with the help of cartoons)**
  - **Maxwell / Hertz / Heaviside**

- **Earliest Radar**
  - **Hulsmeyer / Popov / Marconi**

- **Pre-War Radar**

- **WWII Radar**

- **Post-War Radar**

- **List of IEEE Milestones related to radar**

- **List of IEEE Pioneers in radar**

- **List of D.J. Picard medallist**

Justin Metcalf: Radar Range Equation

- **Dr. Justin Metcalf** received his BS in Computer Engineering from Kansas State University in 2006 where he was a KSU Presidential Scholar. From 2006-2008 he was at the Flight Simulation Labs of Lockheed Martin Aeronautics in Fort Worth, TX. From 2008-2014 he was with the Radar Systems Lab of the University of Kansas, were he obtained an MS in Electrical Engineering in 2011 and a PhD in Electrical Engineering in 2015. He was the recipient of the Richard and Wilma Moore Award for the best departmental MS thesis in 2011-2012. He was a Research Electronics Engineer with the Sensors Directorate of the Air Force Research Laboratory from 2014-2018. Since 2018 he has been an Assistant Professor with the Electrical and Computer Engineering Department at the University of Oklahoma, and a member of the Advanced Radar Research Center.

- Dr. Metcalf was the Chair of the Dayton Chapter of the IEEE Aerospace and Electronic Systems Society from 2016 to 2018. He was a recipient of the Richard and Wilma Moore Award for the best departmental master's thesis from 2011 to 2012 and the 2017 IEEE Dayton Section Young Professionals Award. He was the recipient of a 2020 DARPA Young Faculty Award and the 2023 IEEE AESS Fred Nathanson Memorial Radar Award. He was also appointed as an Aerospace and Defense Faculty Fellow by the Office of the Vice President for Research and Partnerships at the University of Oklahoma. He has been a member of the IEEE AESS Radar Systems Panel since 2020 and was appointed an Associate Editor of the IEEE Transactions on Aerospace and Electronic Systems in 2023. He was the recipient of a DARPA Young Faculty Award in 2020 and is currently an Associate Editor for the IEEE Transactions on Aerospace and Electronic Systems and a member of the IEEE AESS Radar Systems Panel. He is the General Co-Chair of the 2024 IEEE Radar Conference. He has over 70 publications on topics related to radar signal processing, waveform diversity, radar-embedded communications, and game theory. He has been active in radar/communications research for more than 14 years.

- **Radar Phenomenology**
  - **Antenna overview**
  - **Radar range equation**

- **Overview of radar signals**
  - **Range resolution and simple pulses**
  - **Pulse compression waveforms and linear frequency modulated (LFM) waveforms**
  - **Doppler effect**
- **Noise and signal-to-noise ratio**

Justin Metcalf: Introduction to Radar Systems

- **Dr. Justin Metcalf** received his BS in Computer Engineering from Kansas State University in 2006 where he was a KSU Presidential Scholar. From 2006-2008 he was at the Flight Simulation Labs of Lockheed Martin Aeronautics in Fort Worth, TX. From 2008-2014 he was with the Radar Systems Lab of the University of Kansas, were he obtained an MS in Electrical Engineering in 2011 and a PhD in Electrical Engineering in 2015. He was the recipient of the Richard and Wilma Moore Award for the best departmental MS thesis in 2011-2012. He was a Research Electronics Engineer with the Sensors Directorate of the Air Force Research Laboratory from 2014-2018. Since 2018 he has been an Assistant Professor with the Electrical and Computer Engineering Department at the University of Oklahoma, and a member of the Advanced Radar Research Center.

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- **Transmit components**
  - **Waveform generation**
  - **High-power amplification**

- **Mixing**

- **Noise and receive amplification**

- **Sampling & processing considerations**

- **Range-Doppler examples**

Christ Richmond: Estimation and Detection

- **Christ D. Richmond** is a Professor in the Department of Electrical and Computer Engineering at Duke University where he directs the Signals, Information, Inference, and Learning (SIIL) Group. His research interests include statistical signal and array processing, detection and parameter estimation theory, information theory, machine/deep learning, radar/sonar, communications, and spectral sharing. Prior to joining Duke, he was an Associate Professor in the School of Electrical, Computer, and Energy Engineering at Arizona State University, and prior to that Senior Staff in the Advanced Sensor Techniques Group at the MIT Lincoln Laboratory, and a Visiting Lecturer and Associate of the John A. Paulson School of Engineering and Applied Sciences at Harvard University. Prof. Richmond received the Ph.D. degree in electrical engineering from MIT. He is the recipient of the Office of Naval Research Graduate Fellowship Award, the Alan Berman Research Publications Award, and the IEEE Signal Processing Society Young Author Best Paper Award in the area of Sensor Array and Multichannel (SAM) Signal Processing, and he is a Fellow of the IEEE. He has served as the Technical Chairman of the Adaptive Sensor Array Processing Workshop at MIT Lincoln Laboratory and served as a member of the IEEE Technical Committee on SAM Signal Processing. He served as an Associate Editor for the IEEE Transactions on Signal Processing, as a Senior Associate Editor for IEEE Signal Processing Letters (SPL), and currently serves as Editor-in-Chief for IEEE SPL, and as a member of the IEEE Aerospace and Electronics Systems Society (AESS) Radar Systems Panel.

- **Cramér-Rao Bound**

- **Maximum-Likelihood Estimation**

- **Binary Hypothesis Testing**

- **Likelihood Ratio Test**

- **Generalized Likelihood Ratio Test**

- **Radar Processing Examples:**
  - **Matched-filter**
  - **Energy detector**
  - **Sidelobe blanker**
  - **Beam-splitting**

David Schvartzman: Array Signal Processing

- **David Schvartzman** was born in Piracicaba, SP, Brazil, on March 17, 1988. He received the B.S. degree in electrical and computer engineering from the National University of Asunción, San Lorenzo, Paraguay, in 2011, and the M.S. and Ph.D. degrees in electrical and computer engineering from the University of Oklahoma, Norman, OK, USA, in 2015 and 2020, respectively. From 2015 to 2020, he was a Research Scientist with the NOAA National Severe Storms Laboratory (NSSL) and the Cooperative Institute for Severe and High-Impact Weather Research and Operations (CIWRO). At NSSL, he gained key insights on observational needs to improve weather warnings and forecasts. He developed several signal processing algorithms to improve meteorological products that were transitioned to the operational US Weather Surveillance Radar (WSR-88D). From 2021 to mid-2022, he was a Research Scientist with the Advanced Radar Research Center (ARRC) at The University of Oklahoma. Currently, he is an Assistant Professor with the University of Oklahoma School of Meteorology, affiliated with the ARRC. He works on novel signal and array processing algorithms to improve understanding of atmospheric processes using phased array radar. He also works on calibration and integration of phased array radar systems.

- Dr. Schvartzman is also an Adjunct Assistant Professor with the University of Oklahoma School of Electrical and Computer Engineering. He is the recipient of the 2019 American Meteorological Society's Spiros G. Geotis Prize and the 2022 IEEE R5 Outstanding Young Professional Award. He is a Senior Member of the Institute for Electrical and Electronic Engineers (IEEE) and a member of the American Meteorological Society (AMS).

- **Phased Array Radar Architectures and Capabilities (10 mins)**

- **Synthesis of Transmit Beam Patterns (15 mins)**
  - **Beam broadening**
  - **Multiple Simultaneous Beams**
  - **Multiple Concatenated Beams**

- **Digital Beamforming (15 mins)**
  - **Deterministic (Fourier) Beamforming**
  - **Adaptive Beamforming**

- **Cross-polarization Cancelling (10 mins)**

- **Summary (10 mins)**

Shane Flandermeyer: Low Cost GNU Radio Radar Demo

- **Shane Flandermeyer** is a PhD student at the University of Oklahoma's Advanced Radar Research Center (ARRC). His research interests include deep learning, reinforcement learning, radar resource management, and real-time signal processing. He is the recipient of the National Science Foundation (NSF) Graduate Research Fellowship.

- **Commercial off-the-shelf hardware and open-source software for rapid prototyping and experimentation**

- **Real-time signal processing on GPUs**

- **Demonstrations of range doppler and constant false alarm rate (CFAR) detection processing**

Mike Picciolo and Scott Goldstein: STAP

- **Dr. Mike Picciolo** is Senior Technical Director at Anduril Industries, in the Advanced Missions organization. Previously, he was Director of Mission Engineering in the Engineering, Integration and Logistics Division at SAIC. Previously he served as Chief Technology Officer, NSS Division, at ENSCO. Prior, he was the Associate Chief Technologist for Dynetics and Chief Engineer of the Advanced Missions Solutions Group in Chantilly, VA. He has in-depth expertise in Radar, ISR systems, Space Time Adaptive Processing and conducts research in advanced technology development programs. Has deep domain expertise in SAR/GMTI radar, communications theory, waveform diversity, wireless communications, hyperspectral imagery, IMINT, SIGINT, and MASINT intelligence disciplines. He is a member of the IEEE Radar Systems Panel, received the 2007 IEEE Fred Nathanson Radar Engineer of the Year Award, the 2018 IEEE AESS Outstanding Organizational Leadership Award, and founded the IEEE Radar Summer School series.

- **Dr. Scott Goldstein** serves as Senior Vice President, Parsons Corp. Previously Chief Scientist at Anduril Industries. Previously, he was vice President of Engineering, Integration and Logistics Division at SAIC. Prior, he was the Chief Strategy and Technology Officer of ENSCO and Chief Technologist for Dynetics, Inc., and the Manager of the Advanced Missions Solutions Group in Chantilly, VA. He has over 35 years of operational, engineering, leadership and management experience. He has performed fundamental research and development in Radar detection and estimation theory, Space Time Adaptive Processing, as well as in advanced systems concepts involving intelligence sensors, ISR, space superiority capabilities and cyber exploitation. He is a Fellow of the IEEE (for contributions to adaptive detection in radar and communications), a Fellow of the Washington Academy of Sciences and a member of the IEEE Radar Systems Panel. He received the 2002 IEEE Fred Nathanson Radar Engineer of the Year Award.

Mike Picciolo and Scott Goldstein: STAP

- **Part 1 – Introduction, Classic Radar Detection cases.**

- **Part 2 - Space-Time Radar Signal Environment, Optimal Wiener Filter.**

- **Part 3 – Adaptive algorithms, Reduced rank algorithms, Multistage Wiener Filter.**

- **Part 4 – Real world data environments, robust STAP algorithms**

Elisa Giusti: Radar Imaging

- **Elisa Giusti** obtained the specialist degree in Telecommunication Engineering from the University of Pisa in 2006 (cum Laude) and obtained the title of PhD in Remote Sensing at the Department of Information Engineering of the University of Pisa in 2010. She was a Research Fellow at the Department of Information Engineering of the University of Pisa until 2014 and subsequently she worked as a researcher at the National Interuniversity Consortium for Telecommunications (CNIT), and in particular at the National Radar Laboratory and Surveillance Systems (RaSS), where she still works today and where she holds the role of research manager (Head of Research).

- She participated in numerous international research projects, funded by Italian ministries (Ministry of Defence, Ministry of Economic Development, Ministry of University and Research) and European organizations (EDA, ESA, EC), as researcher and as technical and scientific manager. Many of the projects carried out have seen the validation of many technological demonstrators through field trials and demonstrations.

- She is Senior Member of the IEEE and Associate Editor of the IEEE TCI journal. She is author of 107 papers published in international journals and conference proceedings, 1 book and 7 book chapters. She received international awards including the Fall 2021 NATO Sensors and Electronics Technology (SET) Panel Early Career Award (SPECA) and the 2016 Outstanding Information Research Foundation Book publication award for the book Radar Imaging for Maritime Observation. In 2015, she co-founded ECHOES, a radar systems-related spin-off company. Her research interests are mainly in the field of radar systems and radar data processing algorithms.

1) **High resolution Radar**
   a. Definition of radar resolutions
   b. HRRP (High Range Resolution Profile)
   c. 2D High resolution radar
2) **Synthetic Aperture Radar signal model.**
   a. Concept of SAR
   b. Differences between SAR and ISAR systems
3) **ISAR geometry and signal model.**
   a. System geometry
   b. Target modelling
   c. Received signal model
   d. Interpretation of the received signal model
4) **ISAR image formation**
   a. Radial motion compensation
   b. Image formation
      i. Range Doppler
      ii. Back projection
   c. Point Spread Function
   d. Image plane
5) **Applications/Examples of 2D ISAR imaging:**
   a. ISAR from SAR
      i. Theory
      ii. Application and examples
   b. Passive ISAR: examples

Kristine Bell: Target Tracking

- **Kristine Bell** is a Distinguished Fellow at Metron, Inc. and also holds an Affiliate Faculty position in the Statistics Department at George Mason University (GMU). Her technical expertise is in the area of statistical signal processing and multi-target tracking and her current focus is on cognitive and fully adaptive radar, sonar, and electronic warfare systems. She received the B.S. in Electrical Engineering from Rice University in 1985, and the M.S. and Ph.D. from GMU in 1990 and 1995. From 1996-2009, Dr. Bell was an Associate/Assistant Professor in the Statistics Department and C4I Center at GMU. During this time she was also a visiting researcher at the US Army Research Laboratory and the US Naval Research Laboratory. Dr. Bell has served on the IEEE Dennis J. Picard Radar Technologies Medal Selection Committee, the IEEE Jack S. Kilby Signal Processing Medal Selection Committee, the IEEE Aerospace and Electronic Systems Society (AESS) Fellow Evaluation Committee, and the AESS Radar Systems Panel, where she was the chair of the Student Paper Competition Committee. She was the chair of the IEEE Signal Processing Society's Sensor Array and Multichannel (SAM) Technical Committee. She received the GMU Volgenau School of IT & Engineering Outstanding Alumnus Award in 2009 and the IEEE AESS Harry Rowe Mimno Best Magazine Paper Award in 2021. She is a Fellow of IEEE.

- **Single Target Tracking Fundamentals**
  - **Filtering, Smoothing, and Prediction**
  - **Recursive Bayesian Estimation**
  - **Linear Kalman Filter**
  - **Nonlinear Kalman Filters**
  - **Particle Filters**

- **Overview of Advanced Target Tracking Topics**
  - **Data Association**
  - **Track Initiation and Termination**
  - **Multiple Sensor Fusion**
  - **Multiple Target Tracking**

Matt Ritchie and Jon Kraft:
Hands On Lab Exercises

- **Dr. Matthew Ritchie** received an MSci degree in physics from The University of Nottingham, in 2008. Following this he completed an Eng.D degree at University College London (UCL), in association with Thales U.K., in 2013. He continued at UCL as a postdoctoral research associate focusing on machine learning applied to multi-static radar for micro-Doppler classification.

- In 2017 Dr. Ritchie took a Senior Radar Scientist position at the Defence Science and Technology Laboratories (Dstl) which also involved working as the Team Leader for the Radar Sensing group in the Cyber and Information Systems Division. During his time at Dstl he worked on a broad range of cutting edge RF sensing challenges collaborating with both industry and academia.

- As of 2018 he has now taken a academic role at UCL within the Radar Sensing group and was promoted to Associate Professor in 2023. He was awarded a five year Royal Academy of Engineering Fellowship in 2023 partnership with Leonardo UK on the subject of multifunction RF devices. He is a Subject Editor-in-Chief for the IET Electronics Letters journal and a Senior Member of the IEEE.

- **Jon Kraft** joined Analog Devices in 2007, after spending 9 years at Motorola/ON Semiconductor. He is now a principal field applications engineer with a focus in software-defined radio and phased array radar. He posts examples of these concepts, using simple hardware and software, at www.youtube.com/@jonkraft. He is also the architect, and perpetual explorer, of the CN0566 Software Defined Phased Array Radar project, commonly called the "Phaser." He received a B.S.E.E. from Rose-Hulman, a M.S.E.E. from Arizona State University, and has 10 patents issued.

Matt Ritchie and Jon Kraft:
Hands On Lab Exercises

- **Hands On Lab Exercises I: Phased Array Beamforming**

  - **Beam formation**

  - **Tapering**

  - **Grating Lobes**

  - **Monopulse Tracking**

  - **Null Steering**

- **Hands On Lab Exercises II: Radar Signal Processing**

  - **CW Radar**

  - **FMCW Radar**

  - **CFAR Processing**

  - **Range Doppler Processing**

Backups