

Yakov P. Shkolnikov, Ph.D., P.E.
Managing Engineer

Professional Profile

Dr. Shkolnikov specializes in the development and analysis of high performance electronic devices, software, and communication systems.

As the head of the software task force at Exponent, Dr. Shkolnikov assists clients in software and algorithm development, software reliability analysis, and intellectual property evaluations. Dr. Shkolnikov has extensive experience in algorithm design and has developed methods and software in such diverse areas as analysis and visualization of radiological imaging data, computer vision, machine learning, statistical data processing, testing of medical implants, instrumentation of diagnostic systems, internet-protocol (IP) based communication, and analysis of ground penetrating radar data.

He also performs reliability, verification, and validation analysis of software used in medical, automotive, desktop, and embedded applications. He has developed C / C++, LabVIEW, MATLAB, and several other script and controller languages, as well as employed tools such as auto-documenting software and static verifiers (PolySpace).

Dr. Shkolnikov also assists clients in technical analyses supporting complex litigation cases such as class action lawsuits and patent and trade secret litigation. He has experience in infringement, obviousness, and validity analysis of patents for consumer electronic devices and software. He also has assisted clients in locating prior-art and prior-use examples, and has overseen large document and software reviews inherent to such cases.

In addition, Dr. Shkolnikov evaluates and tests systems that produce or communicate via electromagnetic signals. He has experience in electromagnetic interference analysis and exposure assessments of devices and systems as varied as smart meter networks, radar installations, cell phones, radio towers, MRI machines, transmission and distribution lines, consumer electronic devices, and medical device implants.

Dr. Shkolnikov has published over 25 peer-reviewed papers on electrical engineering topics such as semiconductor physics, computer graphics, and electrical safety and has participated in numerous technical conferences on medical device analysis and semiconductors. He has a patent on the security of RFID cards, and has filed several provisional patents on cell phone power management and mechanical strain sensing. Dr. Shkolnikov holds a research faculty appointment at the School of Biomedical Engineering, Science and Health Systems at Drexel University, and is a guest lecturer at Princeton University in the Department of Mechanical & Aerospace Engineering. He is currently a referee for *Health Physics* and was also a referee for *Physical Review Letters* from 2006–2011.

Academic Credentials and Professional Honors

Ph.D., Electrical Engineering (minor in Mechanical Engineering), Princeton University, 2005

M.A., Electrical Engineering, Princeton University, 2004

B.S., Engineering Physics, Cornell University (*summa cum laude*), 1999

Graduated ranked 1st in the School of Engineering, *Summa Cum Laude*, Cornell University; Gordon Wu Fellow, Princeton University; Merrill Presidential Scholar, Cornell University; Tau Beta Pi

2010 IEEE Region 1 Award, Category 3B: Technological Innovation (Industry or Government), for the Development of Mathematical Methods for Computing Ground-Penetrating Radar to Detect Land Mines

The Institute of Electrical and Electronics Engineers/International Committee on Electromagnetic Safety, Subcommittee 4, Safety Levels with Respect to Human Exposure to Radiofrequency Fields (3 kHz to 300 GHz)

Licenses and Registrations

Licensed Professional Engineer, New Jersey, #GE47825

Patents

US Patent No. 7,936,274: Shield for Radio Frequency ID Tag or Contactless Smart Card, issued May 3, 2011 (Shkolnikov Y, Du Y, McGoran B).

Publications

Shkolnikov YP, Bailey WH. Electromagnetic interference and exposure from household wireless networks. 2011 IEEE Symposium on Product Compliance Engineering (PSES), October 2011.

Shkolnikov YP, Bowden A, MacDonald D, Kurtz SM. Wear pattern observations from TDR retrievals using autoregistration of voxel data. *J Biomed Mater Res B Appl Biomater* 2010 August; 94(2):312–317.

Kurtz SM, Ochoa JA, Lau E, Shkolnikov Y, Pavri BB, Frisch D, Greenspon AJ. Implantation trends and patient profiles for pacemakers and implantable cardioverter defibrillators in the United States: 1993–2006. *PACE* 2009. doi: 10.1111/j.1540-8159.2009.02670.

Gokmen T, Padmanabhan M, Gunawan O, Shkolnikov YP, Vakili K, De Poortere EP, Shayegan M. Parallel magnetic-field tuning of valley splitting in AlAs two-dimensional electrons. *Phys Rev B* 2008; 78(23):233306.

Bishop NC, Padmanabhan M, Gunawan O, Gokmen T, De Poortere EP, Shkolnikov YP, Tutuc E, Vakili K, Shayegan M. Valley susceptibility of interacting electrons and composite fermions. *Physica E-Low-Dimensional Systems and Nanostructures* 2008; 4(5):986–989.

McGowan JC, Shkolnikov YP, Sala JB, Ray RM. Diffuse electrical injury: A questionable phenomenon. *Biomedical Engineering Recent Developments*, Nazeran H, Goldman M, Schoepfoerster R (eds), Medical and Engineering Publishers, Inc., ISBN 978-1-930636-06-4, 2008.

McGowan JC, Shkolnikov YP, Sala JB, Ray RM. Diffuse electrical injury: Questioning the scientific basis. *Proceedings, IEEE CCECE Conference, Niagara Falls, Ontario, Canada, 2008.*

Gunawan O, Gokmen T, Shkolnikov YP, De Poortere EP, Shayegan M. Anomalous giant piezoresistance in AIAs 2D electron systems with antidot lattices. *Physical Review Letters* 2008; 100:036602.

Bishop NC, Padmanabhan M, Vakili K, Shkolnikov YP, De Poortere EP, Shayegan M. Valley polarization and susceptibility of composite fermions around a filling factor $\nu=3/2$. *Physical Review Letters* 2007; 98:266–404.

Shayegan M, De Poortere EP, Gunawan O, Shkolnikov YP, Tutuc E, Vakili K. Quantum Hall effect in a multi-valley two-dimensional electron system. *IJMPB* 2007; 21:1388–1397.

Shayegan M, De Poortere EP, Gunawan O, Shkolnikov YP, Tutuc E, Vakili K. Two-dimensional electrons occupying multiple valleys. *AIAs Physica Status Solidi (b)* 2006; 243(14):3629–3642, November.

Gunawan O, Shkolnikov YP, Vakili K, Gokmen T, De Poortere EP, Shayegan M. Valley susceptibility of an interacting two-dimensional electron system. *Physical Review Letters* 2006; 97:186404.

Vakili K, Shkolnikov YP, Tutuc E, De Poortere EP, Padmanabhan M, Shayegan M. High-aobility AIAs quantum wells with out-of-plane valley occupation. *Applied Physics Letters* 2006; 89:172118.

Vakili K, Shkolnikov YP, Tutuc E, Bishop NC, De Poortere EP, Shayegan M. Spin-dependent resistivity and quantum Hall ferromagnetism in two-dimensional electrons confined to AIAs quantum wells. *Physica E* 2006; 34:89.

Vakili K, Gokmen T, Gunawan O, Shkolnikov YP, De Poortere EP, Shayegan M. Dependence of persistent gaps at Landau level crossings on relative spin. *Physical Review Letter* 2006; 97:116803.

Shkolnikov YP, Misra S, Bishop NC, De Poortere EP, Shayegan M. Observation of quantum Hall valley skyrmions. *Physical Review Letters* 2005; 95:066809.

Vakili K, Shkolnikov YP, Tutuc E, Bishop NC, De Poortere EP, Shayegan M. Spin-dependent resistivity at transitions between integer quantum Hall states. *Physical Review Letters* 2005; 94:176402.

Gunawan O, Shkolnikov YP, De Poortere EP, Tutuc E, Shayegan M. Ballistic electron transport in AlAs quantum wells. *Physical Review Letters* 2004; 93:246603.

Shkolnikov YP, Vakili K, De Poortere EP, Shayegan M. Giant low-temperature piezoresistance effect in AlAs two-dimensional electrons. *Applied Physics Letters* 2004; 85:3766.

Shkolnikov YP, Vakili K, De Poortere EP, Shayegan M. Dependence of spin susceptibility of a two-dimensional electron system on the valley degree of freedom. *Physical Review Letters* 2004; 92:246804.

Vakili K, Shkolnikov YP, Tutuc E, De Poortere EP, Shayegan M. Spin susceptibility of two-dimensional electrons in narrow AlAs quantum wells. *Physical Review Letters* 2004; 92:226401.

Vakili K, Shkolnikov YP, Tutuc E, De Poortere EP, Shayegan M. Realization of an interacting two-valley AlAs bilayer system. *Physical Review Letters* 2004; 92:186404.

Shayegan M, Karrai K, Shkolnikov YP, Vakili K, De Poortere EP, Manus S. Low-temperature, in situ tunable, uniaxial stress measurements in semiconductors using a piezoelectric actuator. *Applied Physics Letters* 2003; 83:5235.

De Poortere EP, Shkolnikov YP, Shayegan M. Field-effect persistent photoconductivity in AlAs and GaAs quantum wells with AlGaAs barriers. *Physical Review B* 2003; 67:153303.

Shkolnikov YP, De Poortere EP, Tutuc E, Shayegan M. Valley splitting of AlAs two-dimensional electrons in a perpendicular magnetic field. *Physical Review Letters* 2002; 89:226805.

De Poortere EP, Tutuc E, Shkolnikov YP, Vakili K, Shayegan M. Magnetic-field-induced spin polarization of AlAs two-dimensional electrons. *Physical Review* 2002; B 66:161308.

De Poortere EP, Shkolnikov YP, Shayegan M. High-mobility electrons in modulation-doped AlAs quantum wells. *Physica E* 2002; 13:646.

De Poortere EP, Tutuc E, Shkolnikov YP, Vakili K, Shayegan M, Palm E, Murphy T. Quantum Hall effect in AlAs 2D electron system. *International Journal of Modern Physics B* 2002; 16:2917.

De Poortere EP, Shkolnikov YP, Tutuc E, Papadakis SJ, Shayegan M, Palm E, Murphy T. Enhanced electron mobility and high order fractional quantum Hall states in AlAs quantum wells. *Applied Physics Letters* 2002; 80:1583.

Selected Conference Presentations

Shkolnikov YP, Bailey WH. Electromagnetic interference and exposure from household wireless networks. IEEE Symposium on Product Compliance Engineering, San Diego, CA, October 11, 2011.

Swart J, Shkolnikov YP. Electrical shock and the electric powered vehicles – An introduction to forensics. IEEE Symposium on Product Compliance Engineering, San Diego, CA, October 11, 2011.

Hanzlik JA, Patel JD, JA Ochoa, Shkolnikov YP, Horn QC, Pavri BB, Greenspon AJ, Kurtz SM. Why are implantable cardioverter-defibrillators and pacemakers being revised today? Materials and Processes for Medical Devices Conference and Exposition, Minneapolis, MN, August 8–10, 2011.

Shkolnikov Y, Restrepo C, Parvizi J, Hozack W, Garino J, Suggs J, Kurtz S. Clinical validation of a squeakometer for characterization of acoustic emissions in arthroplasty patients. ORS 55th Annual Meeting, Las Vegas, NV, February 23, 2009.

McGowan JC, Shkolnikov YP, Sala JB, Ray RM. Diffuse electrical injury: Questioning the scientific basis. IEEE Canadian Conference on Electrical and Computer Engineering, Niagara Falls, Ontario, Canada, May 6, 2008.

McGowan JC, Shkolnikov YP, Sala JB, Ray RM. Diffuse electrical injury: A questionable phenomenon. 24th Southern Biomedical Engineering Conference, El Paso, TX, April 19, 2008.

Bowden AE, Shkolnikov YP, MacDonald D, Kurtz SM. Automated microCT-based damage maps of explanted polymeric TDR components. North American Spine Society 22nd Annual Meeting, Austin, TX, October 22–27, 2007.

Bowden AE, Shkolnikov YP, MacDonald D, Kurtz S. Development and validation of an automated MicroCT-based technique for mapping damage of explanted polymeric components for TDR. Spine Arthroplasty Society, Berlin, Germany, 2007.

Padmanabhan M, Bishop N, Shkolnikov YP, De Poortere EP, Shayegan M. Gap and mass measurements of composite fermions at $\nu=5/3$ in a 2D electron system with tunable valley occupation. APS March Meeting, Denver, CO, 2007.

Bishop N, Padmanabhan M, Vakili K, Shkolnikov YP, De Poortere EP, Shayegan M. Valley susceptibility measurements of composite fermions around filling factor $\nu = 3/2$. APS March Meeting, Denver, CO, 2007.

Shkolnikov YP, Gunawan O, Vakili K, Gokmen T, De Poortere E, Shayegan M. Valley susceptibility of an interacting two-dimensional electron system. APS March Meeting, Baltimore, MD, 2006.

Padmanabhan M, Vakili K, Shkolnikov YP, Gunawan O, Gokmen T, Tutuc E, De Poortere EP, Shayegan M. Selective occupation of conduction band valleys in AlAs quantum wells. APS March Meeting, Baltimore, MD, 2006.

Gunawan O, Shkolnikov YP, Vakili K, De Poortere EP, Shayegan M. Giant piezoresistance in AlAs 2D electron systems with antidot lattice. APS March Meeting, Baltimore, MD, 2006.

Vakili K, Gokmen T, Padmanabhan M, Gunawan O, Shkolnikov YP, Tutuc E, Shayegan M. Landau level crossings in imbalanced, two-valley two-dimensional electron systems. APS March Meeting, Baltimore, MD, 2006.

Gunawan O, Shkolnikov YP, Tutuc E, Vakili K, Shayegan M. Antidot lattice in AlAs 2D electron system: Electron pinball with elliptical Fermi contours. APS March Meeting, Los Angeles, CA, 2006.

Vakili K, Y. Shkolnikov, Tutuc E, Bishop N, De Poortere EP, Shayegan M. Spin-dependent resistivity at transitions between integer quantum Hall states. APS March Meeting, Los Angeles, CA, 2006.

Vakili K, De Poortere EP, Shayegan M. Spin susceptibility of two-dimensional electrons in AlAs. PCCM Workshop on Correlated Electronic Materials, Princeton, NJ, 2005.

Shkolnikov YP, Vakili K, De Poortere EP, Shayegan M. Dependence of spin susceptibility of a two-dimensional electron system on valley degree of freedom. 16th International Conference on High Magnetic Fields in Semiconductor Physics, Tallahassee, FL, 2004.

Shkolnikov YP, Tutuc E, Vakili K, Gunawan O, Shayegan M. Physics and technology of AlAs semiconductor devices. Corporate Affiliates Program Meeting, Princeton NJ, 2004.

Shkolnikov YP, Vakili K, Shayegan M. Strain dependence of spin and valley polarization in AlAs 2D electrons. APS March Meeting, Montreal, Canada, 2004.

Gunawan O, Shkolnikov YP, Tutuc E, Shayegan M, De Poortere EP. Valley-resolved ballistic transport in a two-dimensional electron system. APS March Meeting, Montreal, Canada, 2004.

Vakili K, Shkolnikov YP, De Poortere EP, Tutuc E, Shayegan M. Spin polarization of 2D electrons in Narrow AlAs quantum wells. APS March Meeting, Montreal, Canada, 2004.

Shkolnikov YP, De Poortere EP, Vakili K, Tutuc E, Shayegan M, Karrai K, Palm E, Murphy T. stress-induced modification of electronic properties in AlAs 2D electrons. Corporate Affiliates Program Meeting, Princeton, NJ, 2003.

De Poortere EP, Shkolnikov YP, Shayegan M. Field-effect persistent photoconductivity in GaAs/AlAs-based structures. APS March Meeting, Austin, TX, 2003.

Gunawan O, De Poortere EP, Shkolnikov YP, Vakili K, Tutuc E, Shayegan M, Yau JB. Ballistic transport in AIAs 2D electrons. APS March Meeting, Austin, TX, 2003.

Vakili K, Shkolnikov YP, De Poortere EP, Tutuc E, Shayegan M. Magnetoresistance measurements in wide and narrow AIAs quantum wells. APS March Meeting, Austin, TX, 2003.

Shkolnikov YP, De Poortere EP, Vakili K, Tutuc E, Shayegan M. Lifting of the valley degeneracy in AIAs 2D electrons. APS March Meeting, Austin, TX, 2003.

Shkolnikov YP, De Poortere EP, Tutuc E, Shayegan M, Palm E, Murphy T. Magnetic field dependence of valley splitting in AIAs 2D electrons. 15th International Conference on High Magnetic Fields in Semiconductor Physics, Oxford, UK, 2002.

Shkolnikov YP, De Poortere EP, Tutuc E, Shayegan M. Evidence of multi-valley fermi surface in AIAs 2D electrons. APS March meeting, Seattle, WA, 2001.

Skinner CH, Stotler DP, Bell RE, Pitcher CS, Terry JL, Shkolnikov Y. High resolution spectroscopy at Alcator C-mod using a Fabry Perot interferometer. APS, 41st Annual Meeting of the Division of Plasma Physics, Seattle, WA, 1999.

Guest Lectures

Shkolnikov YP. Electricity and the human body. Mechanical Engineering, Princeton University, Princeton, NJ, November 22, 2011, April 8, 2010, April 9, 2009, and 2007.

Shkolnikov YP. Got risk? Managing risk and reliability in modern technology. Cornell Club of Central New Jersey, Princeton, NJ, December 4, 2009.

Villarraga M, Shkolnikov YP. Medical device failure analysis during the design process. Department of Biomedical Engineering, Drexel University, Philadelphia, PA, May 6, 2009.

Shkolnikov YP. Medical device design. North Jersey Section Engineering in Medicine and Biology IEEE Chapter, Clifton, NJ, August 4, 2008.

Villarraga M, Shkolnikov M. FMEA: Risk management and prioritization in medical device design. Thompson Interactive, July 17, 2008.

Shkolnikov YP. Failure analysis during the design process of medical devices. Department of Biomedical Engineering, Drexel University, Philadelphia, PA, 2008.

Shkolnikov YP, Villarraga M. Introduction to electrophysiology. Mechanical Engineering, Princeton University, Princeton, NJ, 2007.

Shkolnikov YP, Villarraga M. Failure analysis during the design process of medical devices. Compliance Online, 2007.

Shkolnikov YP, Villarraga M. Medical device failure analysis during the design process. Department of Biomedical Engineering, Drexel University, Philadelphia, PA, 2007.

Academic Appointments

Visiting Research Professor, School of Biomedical Engineering, Drexel University, 2005–2011

Peer Review

- Referee for *Health Physics*
- Past Referee for *Physical Review Letters*, 2006–2011

Professional Affiliations

- Institute of Electrical and Electronics Engineers
- American Physical Society

Project Experience

Computer Architecture and Networks

- Analysis of computer networks including Internet, WAN, LAN, and smart meter networks
- Analysis of shared memory architecture for mobile computer devices
- Analysis of interrupt handling scheme in mobile processors.
- Software source code analysis (C, C++, Assembly) to identify vulnerabilities and errors in code
- Shielding and interference from RFID and related devices
- Intellectual property/patent investigations semiconductors, software, internet and telephony equipment
- Scalability analysis and improvement of IPTV systems
- Prior art and prior use searches for video game, consumer products, testing equipment and other electronic products
- Patent portfolio review and technical due diligence
- Memory technology analysis and reverse engineering
- Reconstruction of physical geometry and zone mapping of hard drives

Computer Vision and Computer Graphics

- Design of 2D/3D image processing and machine learning algorithms
- Statistical signal processing
- Detection algorithms
- GPGPU software development
- Computer graphics software use and algorithm development

- Analysis of GPU hardware reliability
- Analysis of patent infringement in computer graphics, image processing, and hardware design

Health, Safety, and Medical Products

- Compliance assessment per 47CFR1.1307, 47CFR1.1310, IEEE C95.1, IEEE C95.6, IEC 60601-1-2, IEC 60479-1, ICNIRP 1998, ICNIRP 2010, and other RF and electrical health and safety standards
- Electric shock and electrocution investigations
- Software and methodology development for analysis of FTIR, small punch, tensile testing, tissue property testing, radiological images, and field-testing data
- Assistance in technology transfer product development for biological weapons detection
- Design development, review, and analysis for medical diagnostic equipment companies
- Source code review and modeling to identify failure mode in medical device software
- Failure analysis in medical products including diagnostic equipment, surgical equipment, and implants
- EMI and EMC evaluation of medical products
- Electric and magnetic field exposure and heating from transmission and distribution lines
- Medical products intellectual property analysis
- Risk assessment and FMEA analysis
- Reverse engineering analysis of diagnostic equipment
- Technical analysis of implantable cardioverter defibrillators (ICD), infusion pumps, pacemakers, implantable pulse generators (IPGs), orthopedic implants, blood flow meters, electrosurgical and robotic equipment
- Electromagnetic finite element analysis (AC/DC and RF) of installations

Computer Forensics and Security

- Verification of integrity of the produced digital images: Metadata analysis, image content analysis, photogrammetric analysis
- Enhancement, recovery, and analysis of video surveillance data
- Recovery and analysis of EPROM memory data relating to construction accident
- Data snooping and interception
- Development of automated text and document analysis tools
- Development of technology to secure contents of smart cards
- Security analysis of payment card shipment method
- Security analysis of a data storage and review facility
- Security product performance evaluation
- Validation of hard-drive data sanitization procedure
- Restoring damaged data
- Analysis of wireless transmission systems including encryption, anti-jamming, and error correction

Reliability

- Hardware in the loop testing and probing of microprocessor to identify malfunction
- Electromagnetic finite element analysis (FEA) of components, products, machines, RF exposure, electric shock hazard, reliability, electrostatic discharge, and effects of defects in manufacture and materials
- Electromagnetic interference with the function of GPS systems
- Shielding and interference from RFID and related devices
- Analysis of software and hardware component reliability of automotive products
- Analysis of RF emissions for purposes of a recall decision
- Product misuse investigations

Acoustic Analysis

- Forensic analysis of acoustic data, speech enhancement and other audio data processing, audio acquisition system design and evaluation, waveform/spectral based hearing damage assessment

Semiconductors

- Solid-state sensor design
- Semiconductor packaging design, processing, and failure analysis
- Semiconductor physics
- Intellectual property analysis of fabrication processes, semiconductor materials and devices
- Fiber optic systems
- Low electrical noise systems and data acquisition

Cryogenics, Vacuum, and Magnetic Systems

- Operation and design of cryogenic systems
- Operation, control and design of electromagnetic and permanent magnet systems
- Operation and service of high and ultra high vacuum equipment, systems, and pumps