

Dr. Suren A. Chilingaryan

Data Processing and Performance Expert | Lead of Cloud Computing

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Scholar

OrcID

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I do research in high-performance and heterogeneous computing and apply it to architect online systems for scientific instrumentation. With improvements in detector technology, I believe new approaches are required to keep pace with the increasing data rates. Codesign of hardware, software, and analysis algorithms is often a key to successful projects. Currently, I lead an effort to adopt cloud technologies for data acquisition and control systems.

AREAS OF EXPERTISE

Project Management and Technical Leadership
Parallel and High Performance Computing
Distributed Data Acquisition and Control Systems
Performance Analysis and Software Optimization Techniques
Parallel Algorithms and Parallel Hardware Architectures
Low-latency Communication in Heterogeneous Systems
Cloud-based Data Management and Visualization

TECHNICAL SKILLS

Project Management	Team Building, Proposals & Reports, Technical & Financial Planning
Research	Mentoring & Supervision, Presentation & Publication, Math & Statistics
Programming	C/C++, POSIX/IPC, OpenMP/NPTL, NUMA, SIMD, CUDA/OpenCL
System	Linux & Kernel Internals, PCIe Drivers, DMA/GPUDirect/DirectGMA
Programming	
Networking	Ethernet/Infiniband, EPICS, Sockets/MPI/OMQ, RDMA (ROCe), LibVMA
Software Analysis	gdb, perf/operf, nvvp/nvprof, vtune, valgrind, systap, tcpdump
Data Management	Brokers, Databases (SQL/TSDB/Array/InMem), XML, Web Development
Orchestration	Ansible, Kubernetes/OpenShift, OCI/Docker, LibVirt/KVM, Ceph/GlusterFS

EMPLOYMENT

Since 2020	Leader of Cloud Computing at Karlsruhe Institute of Technology: High-throughput cloud technologies for control and data acquisition applications
2013 – 2022	Data Processing and Performance Expert at KIT: high-performance instrumentation for large-scale scientific experiments
2007 – 2012	Postdoctoral Researcher at KIT: data management & software optimization
2005 – 2007	Software Engineer at Yerevan Physics Institute: data acquisition systems
2002 – 2005	Associate Researcher at Forschungszentrum Karlsruhe
2001 – 2002	Software Engineer at Yerevan Physics Institute

EDUCATION

July 2006	PhD in Computer Engineering “Data Exchange Solution for Distributed Data Acquisition Systems and its application for Cosmic Ray Monitor Networks”, National Academy of Science, Armenia
1996 – 2001	MSc in Mathematics “Data Processing using Neural Networks”, Moscow State University, Russia

PERSONAL DATA

Nationality	Armenian, German Residence Permit (Niederlassungserlaubnis)
Languages	English, Armenian, Russian

PROJECTS

- Since 2018** | **KATRIN-as-a-Service (KaaS) platform for distributed data acquisition systems**
- › Prototyped platform, secured funding, built team, and led rollout
 - › KaaS cloud is integrating data from fast detectors and thousands monitoring sensors
 - › Cut costs by adapting legacy software for distributed ops and integrating HPC resources
 - › Led development of AF_XDP-based, containerized DAQ framework
 - › Modeled data access patterns and guided research on organization of time-series data
 - › Supervised development of online monitoring framework for the KaaS ecosystem
- 2017 – 2022** | **Research and applications of hidden aspects in GPU architectures**
- › Identified performance imbalances and hidden parallelism in NVIDIA and AMD GPUs
 - › Developed method to exploit intra-SM parallelism on NVIDIA (up to 30% speed-up)
 - › Evaluated methods of approximate computing for tomography and accelerated reconstruction algorithms by 4-6 times via performance modeling and rebalancing of hardware usage [s11554-019-00883-w]
- 2012 – 2017** | **Remote-DMA based Data Acquisition Platform**
- › Developed a driver platform for fast prototyping of PCIe-based electronics with a modular (user-space) DMA engine (up to 12 GB/s) and scripting/debugging support
 - › Implemented drivers for in-house electronics, e.g. camera (*in use at KIT and Desy*)
 - › Used RDMA and GPUDirect/DirectGMA to intercommunicate detectors with GPUs
 - › Led a case study on applications of GPUs for CMS track trigger, decision on acceptance of a track candidate was made within 6 μ s (data transfer + analysis)
 - › GPUs allowed to utilize a more precise algorithm than was possible with classic designs
- 2010 – 2017** | **Coordinated student exchange program with Tomsk Polytechnic University**
- 2015 – 2016** | **Cloud platform for collaborative analysis of tomographic data**
- › Led development of web-visualization for large and time-resolved volumes
- 2011 – 2015** | **UFO: Ultrafast tomography with online monitoring and image-based control**
- › Proposed a scalable architecture for pipelined processing of image streams
 - › Coordinated software development with a team in KIT and 3 Russian universities
 - › Supervised development of fast reconstruction algorithms (up to 6 GB/s per node)
 - › Supervised development of regularized reconstruction methods to compensate low SNR and/or undersampling in case of high-speed tomography
 - › Since 2016, the developed system is installed at the KIT synchrotron and enables both high-speed (5 volumes/second) and high-throughput (1000 samples/week) operation
- 2011 – 2014** | **ADEI: Advanced Data Extraction Infrastructure**
- › Helped to secure funding and initiated collaboration between KIT and YerPhI
 - › Supervised a cross-university team of researchers and engineers
 - › Developed a platform for exploration and analysis of time-series in terascale archives
 - › System is in operation in YerPhI, the SEVAN network, and 7 major facilities at KIT
- 2009 – 2013** | **Parallel algorithms and software optimization, 10-100x speed-up**
- › Developed parallel algorithms for μ PIV (micro-particle velocimetry)
 - › Leveraged the PoweXCell architecture for a MRSES feature selection algorithm
 - › Optimized performance of PyHST (ESRF tomographic framework)
 - › Implemented a digital image correlation and tracking algorithm for GPUs
- 2002 – 2008** | **Distributed systems for data acquisition and slow control**
- › Stabilized a slow control system of the KATRIN experiment for production use (*in use*)
 - › Built a distributed data acquisition system for ASEC particle detector networks (*in use*)
 - › Developed drivers for PCI neuro-accelerator and evaluated it for control applications

EXPERIMENTS AND COLLABORATIONS

Current

Since 2020	PANDA: antiProton ANnihilation in Darmstadt, Germany (<i>Member</i>)
Since 2013	BESS: Battery Technology Center at <i>KIT</i> , Germany
Since 2008	KARA: Karlsruhe Research Accelerator, <i>KIT</i> , Germany
Since 2007	KATRIN: Karlsruhe Tritium Neutrino Experiment, Germany (<i>Member</i>)
Since 2006	SEVAN: Space Environment Viewing and Analysis Network; coordinated by <i>YerPhi</i>
Since 2001	ASEC: Aragats Space Environmental Center, Armenia (<i>Member</i>)

Past

2020 – 2021	CCPi: Collaborative Computational Project for Imaging; led by UoM and STFC
2014 – 2018	HZG: Helmholtz-Zentrum Geesthacht, Germany
2010 – 2018	TPU: Tomsk Polytechnic University, Russia
2016 – 2017	CMS: Compact Muon Solenoid, <i>CERN</i>
2016 – 2017	UFO: German-Russian Collaboration on Ultrafast Tomography
2010 – 2017	SCI: Shubnikov Crystallography Institute, Russia
2009 – 2015	KIT Cube: Integrated atmospheric observation system (operated by <i>KIT</i>)
2009 – 2015	KIT Tower: Meteorological tower at <i>KIT</i> North Campus, Germany
2008 – 2014	TOSKA: Test facility for fusion magnets at <i>KIT</i> , Germany
2008 – 2014	ESRF: European Synchrotron Radiation Facility, France

FUNDING

2021	(Author) investments for upgrade of <i>KaaS</i> cluster <i>KATRIN</i> (250 k€) <i>KaaS</i> (2021)
2019	(Technical contribution) to <i>MT-DTS ST2</i> subtopic in <i>Matter and Technologie</i> program Helmholtz MT-DTS (2021 – 2027)
2013, 2016	(Technical contribution) projects on collaborative analysis of tomographic datasets BMBF (750 k€) ASTOR (2013 – 2016) NOVA (2016 – 2020)
2012	(Contributing author) networking grant for cooperation with <i>ASEC</i> BMBF (15 k€) ADEI (2013 – 2015)
2011	(Contributing author) <i>Vaporciyan Multivariate Analysis and Visualization</i> (non-governmental grant by Armenian diaspora) Diaspora (100 k\$) VMAV (2012 – 2014)
2010, 2011	(Contributing author) <i>Ultra Fast X-ray Imaging of Scientific Processes with On-line Assessment and Data-driven Process Control</i> BMBF (2.5 m€) UFO-1 (2010 – 2013) UFO-2 (2012 – 2015)
2009	(Technical contribution) to <i>HDRI (High Data Rate Processing and Analysis)</i> initiative in <i>Helmholtz PNI (Photons, Neutrons, Ions)</i> research program Helmholtz HDRI (2010 – 2014)

LEADERSHIP

Since 2020	Leading efforts to prepare the <i>KATRIN</i> data infrastructure for the <i>Tristan</i> detector Group: 2 engineers PhD 2 students
2018 – 2020	Led development of the <i>KATRIN</i> cloud platform and migration of services Group: 2 Postdocs PhD 2 students
2013 – 2018	Led volume visualization task force in the <i>ASTOR</i> and <i>NOVA</i> projects Group: PhD 5 students
2010 – 2018	Coordinated a program on stewardship of theses for <i>TPU</i> students Participation: 3 PhD 12 students

2010 – 2016	Led a collaboration with <i>ASEC</i> on online data analysis platform Group: Postdoc and PhD in KIT Postdoc and 2 engineers at ASEC 10 students
2010 – 2017	Coordinated a work-package on tomographic software in the <i>UFO</i> project Group: 3 PhD in KIT 3 PhD in partner universities 5 students

RESPONSIBILITIES

Current

Since 2018	Data management cloud at <i>KATRIN</i>
Since 2013	Data management system for <i>KIT Battery Technology Center</i>
Since 2011	Software stack of <i>UFO</i> data acquisition platform
Since 2007	Slow control system at <i>KATRIN</i>

Past

2017 – 2018	Transfer of <i>UFO</i> Camera technology to <i>HZG</i>
2010 – 2017	Parallel computing cluster for <i>UFO</i> project
2013 – 2016	Technology transfer to <i>ASEC</i> and <i>SEVAN</i> experiments
2009 – 2015	Data portal for <i>KIT Cube</i> experiment and <i>KIT Weather Tower</i>
2008 – 2014	Maintenance and optimization of <i>KARA</i> branch of <i>PyHST</i>
2008 – 2014	Data management system at <i>TOSKA</i> and <i>CULTKA</i> facilities
2007 – 2009	Integration of <i>KATRIN</i> components in centralized control system
2005 – 2007	Data acquisition and data management at <i>ASEC</i> and <i>SEVAN</i>
2003 – 2005	Intercommunication between <i>KATRIN</i> DAQ and NI fieldpoint devices
2001 – 2002	IT infrastructure of <i>ASEC</i>

SCIENTIFIC AND OPEN-SOURCE SOFTWARE

Maintain

Since 2018	KaaS: Katrin-as-a-Service data management platform for <i>KATRIN</i> ands.suren.me KATRIN
Since 2015	Bora: monitoring framework for ADEI ecosystem bora.suren.me KATRIN
Since 2011	Alps: Linux driver platform for fast prototyping of PCIe-based electronics alps.suren.me Camera at HZG Camera at SCI Kapture/Kalypso at KARA
Since 2008	ADEI: cloud platform for visualization and analysis of time-series adei.info KATRIN KARA ASEC BESS KIT Tower KIT Cube TOSKA
Since 2005	ADAS: data acquisition system for <i>ASEC</i> detectors adas.suren.me ASEC
Since 2003	RusXMMS: operations with multilingual strings in non-unicode encodings rusxmms.sf.net RedHat OpenSuSE Debian Ubuntu Arch FreeBSD

Supervised and coordinated

2015 – 2018	WAVE: JavaScript volume rendering library based on WebGL wave.suren.me
2012 – 2017	UFO: image-processing framework and a collection of GPU-accelerated algorithms ufo-kit.github.io KARA

Contributions

2020 – 2021	CCPi: Tomographic Imaging Project (<i>performance optimizations</i>) www.ccpai.ac.uk
2008 – 2014	PyHST: <i>ESRF</i> tomography software (<i>DFI algorithm and performance improvements</i>) pyhst2.suren.me KARA ESRF

Obsolete

2010 – 2011	MRSES: feature selection algorithm for Intel and PowerXCell architectures
2009 – 2010	DictHW: CUDA implementation of digital image tracking algorithm
2003 – 2009	XMLBench: XML Benchmarking suite

RESEARCH AND DEVELOPMENT

While the focus of my research is computing technologies, the developed instrumentation enabled major scientific break-throughs achieved by the KATRIN **katrin2019limit** and ASEC **chili2010thunderstorm** collaborations. Below are referenced selected peer-reviewed publications which are either authored by me and my students or where we made a significant contribution.

Since 2011	High-bandwidth data acquisition and data-driven control
2018 – 2019	Fine-tuning of tomographic reconstruction algorithms through micro-benchmarking and performance modeling csa2020rtip UFO PyHST
2016 – 2017	Participated in a case study on applications of GPUs in the Level-1 track trigger for the next upgrade of the CMS experiment mohr2017cms CMS
2016 – 2017	Designed a platform for synchrotron imaging beamlines with a possibility of online reconstruction and an image-based feedback loop kopmann2017ufo, stevanovic2015concert UFO
2015 – 2016	Researched low-latency communication mechanisms for data-driven control applications vogelgesang2016dgma Alps
2014 – 2015	Implemented fast DMA drivers with GPUDirect / DirectGMA support rota2015dma Alps
2013 – 2014	Reviewed asymptotically fast methods of tomographic reconstruction well-fitted for GPU architectures rshkarin2015 UFO PyHST
2011 – 2013	Researched software architectures for online processing of image streams vogelgesang2012ufo UFO
2011 – 2013	Developed a streaming data acquisition platform for scientific cameras caselle2013camera Alps
Since 2007	Parallel architectures, performance analysis, and software optimization
2020 – 2021	Applied methods of approximate computing to enable reconstruction of large datasets using memory-intensive regularization methods ametova2021neutron CCPi
2017 – 2018	Researched performance imbalances and a hidden parallelism in GPU architectures and how they can be exploited to speed-up tomographic reconstruction csa2018sbac PyHST
2014 – 2017	Investigated viable compromises between reconstruction quality and parallelization capabilities of tomographic algorithms ashkarin2015 UFO
2013 – 2014	Developed parallel algorithms for μ PIV (micro-particle velocimetry) cavadini2018upiv UFO
2010	Leveraged the PoweXCell architecture for an MRSES feature selection algorithm (5000x speed-up compared to a MATLAB prototype) MRSES
2009 – 2010	Optimized the PyHST tomographic reconstruction framework csa2011pyhst PyHST

2009 – 2010	Implemented a digital image correlation and tracking algorithm for GPUs	DictHW
2007 – 2008	Carried out a performance study of open-source XML frameworks csa2009xmlbench	XMLBench
Since 1999	Digitization, data organization, and distributed control systems	
Since 2019	Researching cloud technologies for highly heterogeneous control systems in large-scale scientific experiments katrin2021instrument	KaaS
2015 – 2017	Researched remote visualization techniques for large and time-resolved tomographic volumes ntj2017wave, losel2020biomedisa	WAVE
2013 – 2015	Researched emerging web technologies for management and visualization of terabyte-scale archives with time-series	ADEI
2011 – 2014	Converted the KATRIN data management system into a full flagged platform for time-series exploration and analysis	ADEI
2008 – 2010	Developed data management modules of the KATRIN control system csa2010adei	ADEI
2007 – 2008	Stabilized the KATRIN slow control system for production use katrin2015detector	KATRIN
2005 – 2006	Developed a data acquisition system for particle detector networks csa2009sevan	ADAS
2002 – 2004	Researched network protocols for heterogeneous slow control systems eppler2004opc	ADAS
1999 – 2001	Evaluated hardware-accelerated neural networks for trigger applications vardanyan2001sand	

SUPERVISION AND TEACHING

Supervised PhD students

Since 2020	PhD student on adoption of cloud technologies for data acquisition and control systems
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Co-supervised PhD students

2014 – 2018	thesis “Big Data Management and Visualisation”
2013 – 2017	work on collaborative tools for analysis of microtomography data
2013 – 2017	work on low-latency communication protocols for distributed data acquisition systems
2011 – 2016	thesis “An Extensible Parallel Computing Framework for Ultra-Fast X-Ray Imaging”

Supervised MSc and BSc students

2021 – 2021	MSc theses “Fast tomographic reconstruction using parallel and approximate computing”
2021 – 2021	3 MSc theses on database and cloud technologies for slow-control systems of large-scale experiments
2014 – 2018	5 MSc theses on remote visualization of archives with tomographic data
2013 – 2017	4 students working on fast DMA interconnects between FPGA and GPUs
2011 – 2016	4 MSc and 2 BSc theses on advanced algorithms in tomographic reconstruction
2010 – 2015	10 internships on web technologies for visualization of time series
2014	2 MSc theses on GPU-accelerated algorithms for nano-particle tracking

Courses and seminars

2019	GPU computing tutorial at ARBRA summer school in Nor-Amberd, Armenia
2014 – 2017	4 student projects at seminar “Advanced topics in Parallel Programming”
2013	GPU computing tutorial at KSETA graduate school at KIT

SELECTED PRESENTATIONS

Conferences

Oct 2019	(invited) “ <i>Accelerating Remote Visualization of Large Tomographic Data Volumes</i> ” at Global Innovation Forum, Armenia
Oct 2018	(talk) “ <i>Balancing load of GPU subsystems to accelerate image reconstruction in parallel beam tomography</i> ” at SBAC-PAD 2018 conference, Lyon, France
Okt 2014	(talk) “ <i>Computing Infrastructure for Online Monitoring and Control of High-throughput DAQ Electronics</i> ” at 10th PCAPAC conference, Karlsruhe, Germany
Sep 2014	(invited) “ <i>UFO – Status and Perspectives of Ultrafast X-Ray Imaging at ANKA</i> ” and “ <i>Fast Reconstruction Algorithms for Computed Tomography</i> ” at SNI 2014, Germany
Jun 2012	(talk) “ <i>A High Throughput Platform for Real-Time X-ray Imaging</i> ” and “ <i>Advanced Linux PCI Services</i> ” at 18th IEEE Real-Time Conference, Berkeley, CA, USA
May 2012	(talk) “ <i>A High Performance Platform for Real-Time X-ray Imaging</i> ” at GPU Technology Conference, San Jose, CA, USA
May 2010	(talk) “ <i>A GPU-based Architecture for Real-Time Data Assessment at Synchrotron Experiments</i> ” at 17th IEEE Real-Time Conference, Lisbon, Portugal
Apr 2009	(talk) “ <i>Comparison of fast multi-platform XML Libraries: Results for January 2009</i> ” at BenchmarX’09 workshop at DASFAA 2009, Brisbane, Australia
Sep 2007	(talk) “ <i>Advanced Data Acquisition System for SEVAN</i> ” at SEE 2007 Symposium, Athens, Greece

Workshops

Mar 2019	(talk) “ <i>UFO Cloud: Data-Acquisition-as-a-Service</i> ” at Matter and Technologie program meeting, Germany
Nov 2018	(talk) “ <i>High-Speed Tomography: Fine-tuning back projection for GPU architectures</i> ” at CAMERA workshop, Berkeley, CA, USA
Nov 2017	(invited) “ <i>UFO - A platform for high data rate instrumentation with GPUs</i> ” at EUCALL GPU/FPGA Workshop at XFEL, Hamburg, Germany
May 2017	(invited) “ <i>SHAPE: Scalable and Highly Available Platform for Scientific Data Portals</i> ” at ARBRA Workshop, Nor-Amberd, Armenia
Apr 2017	(invited) “ <i>Tuning tomographic reconstruction for different parallel architectures</i> ” at workshop on Real-Time 3D Tomography, CWI, Amsterdam, Netherlands
Jan 2016	(invited) “ <i>Performance-oriented instrumentation for high-speed synchrotron imaging</i> ” at workshop on Large Scale Tomography, Szeged, Hungary
Apr 2012	(invited) “ <i>ADEI for Tango</i> ” at Tango workshop, MAX-IV, Lund, Sweden
Mar 2012	(talk) “ <i>Practical Experience with GPUs for high throughput computing</i> ” at HDRI/PanData workshop
Mar 2011	(invited) “ <i>High Speed Tomography at KIT</i> ” at meeting on Tomographic reconstruction software, ESRF
Sep 2008	(talk) “ <i>Advanced Data Extraction Infrastructure</i> ” at FORGES 2008 workshop, Nor-Amberd, Armenia

Seminars

May 2020	(talk) “ <i>Real-time reconstruction for synchrotron tomography</i> ” at lunch-and-learn session at University of Manchester, UK
Oct 2018	(talk) “ <i>Balancing load of GPU subsystems to accelerate back projection for synchrotron tomography</i> ” at ESRF, Grenoble, France
Apr 2016	(talk) “ <i>ADEI: Intelligent visualization and management of time-series data in scientific experiments</i> ” at Instituto de Física, UNAM, Mexico
May 2015	(talk) “ <i>Advanced Algorithms for Tomography</i> ” at YerPhI seminar, Yerevan, Armenia
Sep 2013	(talk) “ <i>Ultrafast X-Ray Imaging of Scientific Processes</i> ” at SCI and TPU, Russia