

SAFARI

SAFARI Research Group

ETH zürich

Newsletter

December 2025



safari.ethz.ch

Table of Contents



03	Letter from Prof. Onur Mutlu
04	SAFARI Vision
05	News, Awards and Interviews
10	Recent Graduates
12	Publications
18	SAFARI Seminars and Workshops
22	Our Courses
27	Partners
28	What's Next?
30	Contact Information

Letter from Prof. Mutlu

3



I am pleased to share our group research highlights since our last newsletter. I am proud to have a very diverse and talented set of group members, with many successful PhD and postdoc alumni who have gone on to influential industry and academic careers. We have many accomplishments to celebrate this past year, including the successful graduations of four of our PhD students, passing the milestone of our 25th PhD student graduating from SAFARI.

Over the last 15 years, SAFARI has been built on the goal of contributing groundbreaking research and solving important problems in computer architecture. Our group culture and motivation has been shaped by many inspirational and diverse research cultures and ideas over the years, which we try to encourage and nurture through a strong collaborative style and a diverse and talented set of people, starting at CMU and which has continued to ETH. We look forward to continuing our productive and impactful work in 2026, expanding our collaborations, and always maintaining a continued dedication to sharing our passion in both research and teaching globally. We hope you enjoy this edition of our newsletter and we would like to wish you a wonderful end of year season and start in 2026!



SAFARI Research group conducts cutting-edge research and education in computer architecture, computing systems, hardware security, bioinformatics, and software/hardware co-design. The major goal is to design fundamentally better computing architectures. Our work spans the boundaries between applications, systems, languages, system software, compilers, and hardware, with architecture at the core. We tackle many fundamental issues in high performance, energy efficiency, hardware security, fault tolerance, predictable systems, dependable systems, hardware/software cooperation, and genome analysis. We are especially excited about novel, fundamentally-secure and fundamentally-efficient computation, communication and memory/storage paradigms. Recent impactful examples of the group's work include leading research into memory/storage systems and new computing paradigms, e.g., the discovery of the DRAM RowHammer, RowPress and ColumnDisturb vulnerabilities and the development of a comprehensive Processing-in-Memory paradigm.



2025 Harry H. Goode Memorial Award

Prof. Onur Mutlu was awarded the IEEE Computer Society's 2025 **Harry H. Goode Memorial Award** for his **seminal contributions to computer architecture research and practice, especially in memory systems**. The Goode Award is given to individuals for their achievements in the information processing field which are considered either a single contribution of the

theory, design, or technique of outstanding significance, or the accumulation of important contributions on theory or practice over an extended time period. The award has been given since 1964 and several computing pioneers have received it, including Konrad Zuse, Eckert-Mauchly, Maurice Wilkes, Grace Hopper, Seymour Cray, Edsger Dijkstra and Gordon Moore.

Watch video highlighting [Prof. Onur's Contributions](#) | Read [Prof. Onur's Statement](#)

Learn about the [Goode Award and its recipients](#)

Distinguished Artifact Award for PaCRAM at HPCA 2025

Our paper **PaCRAM: Understanding RowHammer Under Reduced Refresh Latency: Experimental Analysis of Real DRAM Chips and Implications on Future Solutions** is one of two papers (out of 534 submissions) that received this award. Our experimental study shows that the preventive refresh latency for the RowHammer vulnerability in DRAM can be

reduced by 64% with only a 0.54% increase in refresh frequency. Leveraging this, our new PaCRAM mechanism lowers the performance and energy costs of existing RowHammer mitigations, providing a low-cost path to securing modern memory. Read [Paper](#) | Download [Source Code](#)



Test of Time Award for AVATAR

Our 2015 paper **"AVATAR: A Variable-Retention-Time (VRT) Aware Refresh for DRAM Systems"** has received the **DSN 2025 Test of Time Award**. The award recognizes two outstanding papers that have had a sustained impact on the theory and practice of dependable systems and networks computing research in the last decade. Learn about [AVATAR](#)



Giray receives ACM SIGMICRO Dissertation Award

A. Giray Yağlıkçı has been awarded the ACM SIGMICRO Dissertation Award for his doctoral thesis "**Enabling Efficient and Scalable DRAM Read Disturbance Mitigation via New Experimental Insights into Modern DRAM Chips**". Giray has recently become

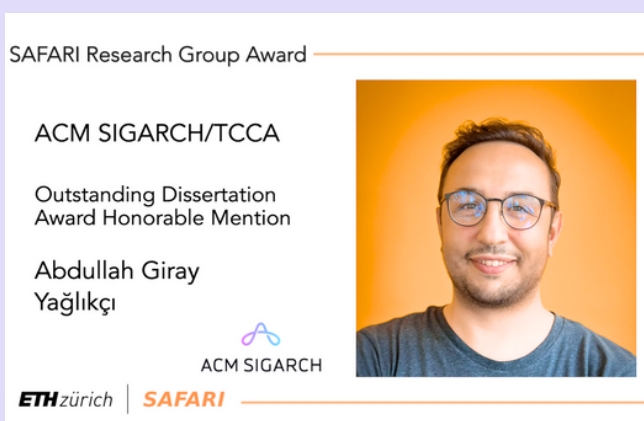
a faculty member at CISPA Helmholtz Center for Information Security in Saarbrücken, Germany.

Read [Giray's PhD thesis](#) | Watch [Giray's Research Talk](#)

William C. Carter Award for Giray

A. Giray Yağlıkçı was awarded the **DSN-2025 William C. Carter PhD Dissertation Award in Dependability**.

The Award recognizes significant contribution to the field of dependable and secure computing and commemorates the late William C. Carter, a key figure in the field of dependable computing.



ACM SIGARCH/TCCA Outstanding Dissertation Award

A. Giray Yağlıkçı received an Honorable Mention at the 2025 ACM-SIGARCH/IEEE-CS TCCA **Outstanding Dissertation Award** ceremony for his dissertation.

VIS Teaching Award for Maria

Maria Makeenkova received the **VIS Teaching Award for 2024** for our Digital Design and Computer Architecture (DDCA) course. The award is given by the Association of Computer Science Students at the ETH Zurich to recognise the favorite teaching assistants in D-INFK, as voted by the students in D-INFK.



SAFARI Research Group Award

IEEE/ACM International Symposium on Computer Architecture (ISCA) Hall of Fame 2025

Congratulations on being inducted into the ISCA Hall of Fame



Mohammad Sadrosadati



Abdullah Giray Yağlıkçı

ETH zürich | SAFARI

Mohammad and Giray inducted into ISCA Hall of Fame

Mohammad Sadrosadati and A. Giray Yağlıkçı were inducted into the IEEE/ACM International Symposium on Computer Architecture (ISCA) **Hall of Fame at ISCA 2025** for their significant research contributions from 2018 – 2025. The Hall of Fame recognizes authors with

with eight or more papers published in the ISCA proceedings. Learn about their [Research Contributions](#)

Ataberk and Giray inducted into the HPCA Hall of Fame

Ataberk Olgun and Giray Yağlıkçı were inducted into the **IEEE International Symposium on High-Performance Computer Architecture (HPCA)'s Hall of Fame**. HPCA is the premier forum for presenting new ideas and research results in computer architecture and its [Hall of Fame](#) recognizes authors with eight or more papers published in the HPCA proceedings. Learn about their [Research Contributions](#)



Konstantinos joins the MICRO Hall of Fame

Konstantinos Kanellopoulos was inducted into the **ACM SIGMICRO MICRO Hall of Fame**. The Hall of Fame recognizes authors who have had eight or more papers published in MICRO.

Learn about his [Research Contributions](#) | View [MICRO Hall of Fame](#)

Impact Award of the RSE Society for Lukas

Lukas Breitwieser received the award for his significant impact on the field of agent-based simulation, through his contributions to the high-performance and extreme-scale simulation platforms BioDynaMo and TeraAgent, which he developed during his [PhD](#).

Learn about [Lukas's Research Contributions](#)



Can We Do Better?

Onur Mutlu
omutlu@gmail.com
<https://people.inf.ethz.ch/omutlu>
21 October 2025
Keynote Talk at MICRO 2025, Seoul
SAFARI ETH zürich

Some Questions to Ponder

- Do all research ideas need to be commercially viable?
 - If yes, when? Immediately? How can one predict the future?
- Can a "non-viable" idea become viable?
 - Or inspire something else that could be useful?
- Does a paper have to solve all problems with an idea?
 - Or can it do enough to enable fast & efficient progress?
- Are all reviews bias free and hidden/visible-COI free?
 - Or should we simply accept more works to enable fast progress?
- What do we lose from being more positive and accepting?

Click on Slide to watch the keynote talk

Can We Do Better? Keynote Talk by Prof. Onur Mutlu at MICRO 2025

In this [Keynote Talk](#), Prof. Mutlu critically examines various aspects of computing system design and the research & development process that goes into it. He deconstructs some of the assumptions that go into various design, research, and development processes, with the goal of enabling and hopefully inspiring better and fundamentally more efficient ways of doing things. He deconstructs the key assumption of processor-centric design mindset and paradigm of thinking about and designing computing systems, which is hitting many scaling limits. Other issues, including how we analyze and vet scientific research and its broader implications are examined.

The Next Computing Revolution: Bringing Processing Inside Memory

In this [interview](#) with IEEE Computer Society INSIDER, Prof. Onur Mutlu argues for a paradigm shift toward Processing-in-Memory (PIM) to solve the energy and performance bottlenecks caused by data movement in traditional processor-centric systems. Despite resistance ingrained in current education and business models, his group drives adoption through open-source software stacks, FPGA-based testing infrastructures, and rigorous simulators like Ramulator and MQSim. These tools have enabled major discoveries like Functionally-Complete computation and True Random Number Generation capability in commodity DRAM and empower the broader community to validate and implement memory-centric designs.

Read [Interview](#)

Building the Future of Robust Computing Systems

IEEE Computer Society INSIDER interviewed Prof. Onur Mutlu on receiving the [2025 Harry H. Goode Memorial Award](#). In the [interview](#), Onur discusses his seminal discovery of RowHammer, a critical DRAM vulnerability, which fundamentally shifted the industry's approach to hardware security. His research proved that commodity hardware is fallible, triggering a decade of defensive innovations that forced major manufacturers to standardize solutions like Per-Row Activation Counters. Onur emphasizes the necessity of bridging academia and industry, noting how his work on memory scaling and processing-in-memory has been directly adopted by companies like Intel, Samsung, and Google.

Read [Interview](#)

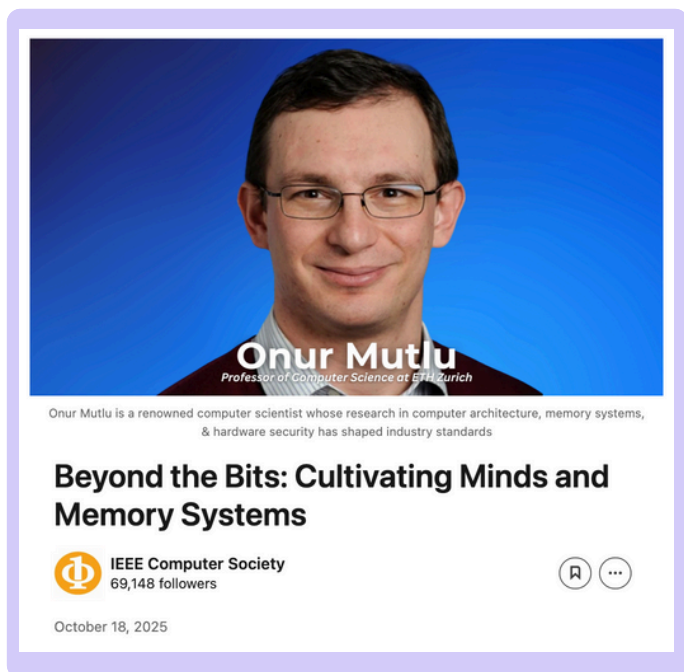
An Idea Whose Time Has Come, HiPEAC 2024 interview with Prof. Mutlu

In this [interview](#), Prof. Mutlu discusses what's changed in the role of memory in computing systems since his [2018 HiPEAC interview](#). Dr. Mutlu details the rapid evolution of Processing-in-Memory (PIM) from academic theory to commercial reality as the essential solution to the

energy and performance bottlenecks caused by data movement. He emphasizes that disruptive hardware must be supported by a robust software stack and "global co-design" to optimize critical workloads like AI and genomics from algorithms down to devices. Future architectures, he argues, must prioritize sustainability and robustness through data-driven, self-optimizing controllers and the integration of emerging 3D technologies. Read [Interview](#)



An idea whose time has come
Onur Mutlu on processing in memory, holistic architecture design and fundamentally better computing systems



Beyond the Bits: Cultivating Minds and Memory Systems

In this [article](#) for IEEE Computer Society, Prof. Onur Mutlu advocates for the evolution of hardware into self-optimizing, data-driven architectures where intelligent agents replace static heuristics to manage system resources, alongside specialized accelerators for genomics and AI. He emphasizes the necessity of heterogeneous integration and advanced packaging to enable memory-centric computing, while prioritizing robustness and security in increasingly critical infrastructure. Committed to democratizing

education, he actively open-sources research tools and livestreams lectures, creating a global classroom that impacts millions of students and industry engineers. His mentorship philosophy fosters innovation by combining intellectual freedom with rigorous scientific evaluation, creating a collaborative environment focused on long-term problem-solving rather than short-term publication metrics.

Read [Article](#)

Rahul Bera

Rahul is our 25th PhD graduate and he successfully defended his PhD thesis on the 1st of October 2025. The thesis titled **"Mitigating the Memory Bottleneck with Machine-Learning-Driven and Data-Aware Microarchitectural Techniques"**, proposes novel mechanisms for general-purpose processors that continuously adapt their policies and decisions based on patterns and characteristics of both application and system-generated data. His research on applying practical machine-learning-based methods in processor microarchitecture design has won best paper awards in two flagship computer architecture conferences, MICRO'22 and ISCA'24. The key contributions of his research are:



- Pythia: A Customizable Hardware Prefetching Framework Using Online Reinforcement Learning (MICRO'21)
- Hermes, which introduces perceptron-learning based off-chip load prediction mechanism (MICRO'22)
- Constable, which simultaneously improves performance and power efficiency by exploiting repeatable data characteristics (ISCA'24)
- Athena, which demonstrates online reinforcement learning for coordinating data prefetchers with off-chip load prediction (accepted to HPCA'26)

Read our **Interview with Rahul** where he shares more about his doctoral thesis, the impact and future directions of his research, and about his PhD experience at the SAFARI group.

Dr. Rahul Bera is currently seeking industrial research positions. Reach out to him on [his website](#).

Dr. Geraldo Francisco de Oliveira Junior

Geraldo successfully defended his PhD thesis on the 29th of April 2025. The thesis titled **"New Tools, Programming Models, and System Support for Processing-in-Memory Architectures"** aimed to effectively exploit the inherent parallelism of PIM architectures and facilitate their adoption through end-to-end design of hardware and software support. His thesis work made significant contributions to holistically and efficiently adopting PIM in computing systems, including:



- Identifying and characterizing data movement bottlenecks (DAMOV, IEEE Access'21)
- Providing programming and system support for end-to-end PUM (MIMDRAM, HPCA'24)
- Enabling data-aware optimizations for efficient PUM execution (Proteus, ICS'25)
- Designing programming frameworks to aid PIM programmability (DaPPA, PACT SRC'23)

Dr. Can Firtina

Can's thesis on "**Enabling Fast, Accurate, and Efficient Real-Time Genome Analysis via New Algorithms and Techniques**"

made significant contributions to mitigating noise in sequencing data and analysis allowing for accurate, scalable, and real-time analysis of sequencing data and enabling new applications in genome analysis. His work enabled novel applications, including:

- BLEND addresses noise in basecalled sequencing data analysis by providing an effective hash-based search method for noise tolerance.
- RawHash targets noise in raw nanopore sequencing data to reduce noise and enable hash-based search for rawsignals.
- RawHash2 improves our understanding of noise in raw nanopore signals, allowing for better noise reduction.
- Rawsample enables a new application by overlapping raw nanopore signals to build assemblies without basecalling.



Dr. Can Firtina is currently Assistant Professor at the [University of Maryland, College Park](#) where he leads the [STORM Research Lab](#). Read more about Can's [doctoral defense](#).

Dr. Lukas Breitwieser

Lukas's thesis is titled "**Design and Analysis of an Extreme-Scale, High-Performance, and Modular Agent-Based Simulation Platform**" and over the course of the doctoral

research he developed the high-performance simulation engine, BioDynaMo, and its significant improvement TeraAgent. Since its publication and open source release, researchers have used BioDynaMo to study radiation-induced lung injuries, vascular tumor growth, invasion of Gliomas into surrounding tissue, the formation of retinal mosaics in the eye, freezing and thawing of cells, neuronal geometries, the formation of the cortical layers in

cerebral cortex, the spread of viruses on a country-scale, and more. BioDynaMo and TeraAgent set a new standard for agent-based simulation platforms by combining high performance, scalability, modularity and user-friendliness. TeraAgent is the first agent-based simulation platform that supports more than 500 billion agents, and is poised to enable even larger simulations with current, ongoing work.

Dr. Lukas Breitwieser is currently Research Software Engineer at CERN.

Read more about Lukas's [doctoral defense](#).



- Ismail Emir Yüksel, Ataberk Olgun, F Bostanci, Oguzhan Canpolat, Geraldo F Oliveira, Mohammad Sadrosadati, Abdullah Giray Yaglikci, Onur Mutlu, **"In-DRAM True Random Number Generation Using Simultaneous Multiple-Row Activation: An Experimental Study of Real DRAM Chips"** 43rd IEEE International Conference on Computer Design (ICCD-43), October 2025.
- F. Nisa Bostancı, Oğuzhan Canpolat, Ataberk Olgun, İsmail Emir Yüksel, Konstantinos Kanellopoulos, Mohammad Sadrosadati, A. Giray Yağlıkçı, and Onur Mutlu, **"Understanding and Mitigating Covert Channel and Side Channel Vulnerabilities Introduced by RowHammer Defenses"** Proceedings of the 58th IEEE/ACM International Symposium on Microarchitecture (MICRO), October 2025.
- İsmail Emir Yüksel, Ataberk Olgun, F. Nisa Bostancı, Haocong Luo, A. Giray Yağlıkçı, and Onur Mutlu, **"ColumnDisturb: Understanding Column-based Read Disturbance in Real DRAM Chips and Implications for Future Systems"** Proceedings of the 58th IEEE/ACM International Symposium on Microarchitecture (MICRO-58), October 2025.
- Marzieh Barkhordar, Alireza Tabatabaeian, Mohammad Sadrosadati, Christina Giannoula, Juan Gomez Luna, Izzat El Hajj, Onur Mutlu, Alaa Alameldeen, **"ALPHA-PIM: Analysis of Linear Algebraic Processing for High-Performance Graph Applications on a Real Processing-In-Memory System"** Accepted in 2025 IEEE International Symposium on Workload Characterization, October 2025.
- Haocong Luo, Ataberk Olgun, Maria Makeenkova, F. Nisa Bostanci, Geraldo F. Oliveira, A. Giray Yaglikci, and Onur Mutlu, **"Cleaning up the Mess"** arXiv preprint, October 2025.
- Furkan Eris, Ulysse McConnell, Can Firtina, and Onur Mutlu, **"RawBench: A Comprehensive Benchmarking Framework for Raw Nanopore Signal Analysis Techniques"** Accepted in ACM BCB, October 2025.
- Lukas Breitwieser, Ahmad Hesam, Abdullah Giray Yağlıkçı, Mohammad Sadrosadati, Fons Rademakers, and Onur Mutlu, **"TeraAgent: A Distributed Agent-Based Simulation Engine for Simulating Half a Trillion Agents"** arXiv preprint, September 2025.
- Gaurav Sharma, Viorel Munteanu, Nika Mansouri Ghiasi, Jineta Banerjee, Susheel Varma, Luca Foschini, Kyle Ellrott, Onur Mutlu, Dumitru Ciorbă, Roel A. Ophoff, Viorel Bostan, Christopher E Mason, Jason H. Moore, Despoina Sousoni, Arunkumar Krishnan, Christopher E. Mason, Mihai Dimian, Gustavo Stolovitzky, Fabio G. Liberante, Taras K. Oleksyk, and Serghei Mangul, **"A decentralized future for the open-science databases"** arXiv preprint, September 2025.
- Maciej Besta, Florim Memedi, Zhenyu Zhang, Robert Gerstenberger, Guangyuan Piao, Nils Blach, Piotr Nyczky, Marcin Copik, Grzegorz Kwaśniewski, Jurgén Müller, Lukas Gianinazzi, Ales Kubicek, Hubert Niewiadomski, Aidan O'Mahony, Onur Mutlu, Torsten Hoeffler, **"Demystifying chains, trees, and graphs of thoughts"** in IEEE Transactions on Pattern Analysis and Machine Intelligence, August 2025.
- Konstantinos Kanellopoulos, Konstantinos Sgouras, Andreas Kosmas Kakolyris, Vlad-Petru Nitu, Berkin Kerim Konar, Rahul Bera, and Onur Mutlu, **"Revelator: Rapid Data Fetching via OS-Driven Hash-based Speculative Address Translation"** arXiv preprint, August 2025.
- Mostafa Kishani, Sina Ahmadi, Saba Ahmadian, Reza Salkhordeh, Zdenek Becvar, Onur Mutlu, André Brinkmann, Hossein Asadi, **"ELICA: Efficient and Load Balanced I/O Cache Architecture for Hyperconverged Infrastructures"** in IEEE Transactions on Parallel and Distributed Systems, July 2025.

- F Nisa Bostancı, Konstantinos Kanellopoulos, Ataberk Olgun, A Giray Yağlıkçı, İsmail Emir Yüksel, Nika Mansouri Ghiasi, Zülal Bingöl, Mohammad Sadrosadati, Onur Mutlu, "**Revisiting Main Memory-Based Covert and Side Channel Attacks in the Context of Processing-in-Memory**" 55th Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN), June 2025.
- Kangqi Chen, Andreas Kosmas Kakolyris, Rakesh Nadig, Manos Frouzakis, Nika Mansouri Ghiasi, Yu Liang, Haiyu Mao, Jisung Park, Mohammad Sadrosadati, and Onur Mutlu, "**REIS: A High-Performance and Energy-Efficient Retrieval System with In-Storage Processing**" Proceedings of the 52nd International Symposium on Computer Architecture (ISCA-52), June 2025.
- İsmail Emir Yüksel, Akash Sood, Ataberk Olgun, Oğuzhan Canpolat, Haocong Luo, Nisa Bostancı, Mohammad Sadrosadati, Giray Yaglikci, Onur Mutlu, "**PuDHammer: Experimental Analysis of Read Disturbance Effects of Processing-using-DRAM in Real DRAM Chips**" Proceedings of the 52nd Annual International Symposium on Computer Architecture (ISCA-52), June 2025.
- Oğuzhan Canpolat, Ataberk Olgun, David Novo, Oğuz Ergin, Onur Mutlu, "**EasyDRAM: An FPGA-based Infrastructure for Fast and Accurate End-to-End Evaluation of Emerging DRAM Techniques**", arXiv preprint, June 2025.
- Geraldo F. Oliveira, Mayank Kabra, Yuxin Guo, Kangqi Chen, A. Giray Yağlıkçı, Melina Soysal, Mohammad Sadrosadati, Joaquin Olivares Bueno, Saugata Ghose, Juan Gómez-Luna, and Onur Mutlu, "**Proteus: Enabling High-Performance Processing-Using-DRAM with Dynamic Bit-Precision, Adaptive Data Representation, and Flexible Arithmetic**" Proceedings of the 39th ACM International Conference on Supercomputing, June 2025.
- Melina Soysal, Konstantina Koliogeorgi, Can Firtina, Nika Mansouri Ghiasi, Rakesh Nadig, Haiyu Mao, Geraldo Francisco de Oliveira Junior, Yu Liang, Klea Zambaku, Mohammad Sadrosadati, Onur Mutlu, "**MARS: Processing-in-memory acceleration of raw signal genome analysis inside the storage subsystem**" Proceedings of the 39th ACM International Conference on Supercomputing, June 2025.
- William Andrew Simon, Leonid Yavits, Konstantina Koliogeorgi, Yann Falevoz, Yoshihiro Shibuya, Dominique Lavenier, Irem Boybat, Klea Zambaku, Berkan Şahin, Mohammad Sadrosadati, Onur Mutlu, Abu Sebastian, Rayan Chikhi, The BioPIM Consortium, and Can Alkan, "**Processing-in-memory for genomics workloads**" arXiv preprint, June 2025.
- Lorenzo Asquini, Manos Frouzakis, Juan Gómez-Luna, Mohammad Sadrosadati, Onur Mutlu, and Francesco Silvestri, "**Accelerating Triangle Counting with Real Processing-in-Memory Systems**" arXiv preprint, May 2025.
- Onur Mutlu, Ataberk Olgun, and İsmail Emir Yüksel, "**Memory-Centric Computing: Solving Computing's Memory Problem**" Invited Paper in Proceedings of the 17th IEEE International Memory Workshop (IMW), May 2025
- Haocong Luo, İsmail Emir Yüksel, Ataberk Olgun, A Giray Yağlıkçı, Onur Mutlu, "**Revisiting DRAM Read Disturbance: Identifying Inconsistencies Between Experimental Characterization and Device-Level Studies**", IEEE 43rd VLSI Test Symposium (VTS), April 2025.

- Manos Frouzakis, Juan Gómez-Luna, Geraldo F. Oliveira, Mohammad Sadrosadati, and Onur Mutlu, **"PIMDAL: Mitigating the Memory Bottleneck in Data Analytics using a Real Processing-in-Memory System"** arXiv preprint, April 2025.
- Nika Mansouri Ghiasi, Talu Güloglu, Harun Mustafa, Can Firtina, Konstantina Koliogeorgi, Konstantinos Kanellopoulos, Haiyu Mao, Rakesh Nadig, Mohammad Sadrosadati, Jisung Park, and Onur Mutlu, **"SAGE: A Lightweight Algorithm-Architecture Co-Design for Mitigating the Data Preparation Bottleneck in Large-Scale Genome Sequence Analysis"** arXiv preprint, April 2025.
- Konstantinos Kanellopoulos, Konstantinos Sgouras, F Nisa Bostanci, Andreas Kosmas Kakolyris, Berkin Kerim Konar, Rahul Bera, Mohammad Sadrosadati, Rakesh Kumar, Nandita Vijaykumar, Onur Mutlu, **"Virtuoso: Enabling fast and accurate virtual memory research via an imitation-based operating system simulation methodology"** Proceedings of the 30th ACM International Conference on Architectural Support for Programming Languages and Operating Systems, March 2025.
- Mayank Kabra, Rakesh Nadig, Harshita Gupta, Rahul Bera, Manos Frouzakis, Vamanan Arulchelvan, Yu Liang, Haiyu Mao, Mohammad Sadrosadati, and Onur Mutlu, **"CIPHERMATCH: Accelerating Homomorphic Encryption-Based String Matching via Memory-Efficient Data Packing and In-Flash Processing"** arXiv preprint, March 2025.
- Rakesh Nadig, Vamanan Arulchelvan, Rahul Bera, Taha Shahroodi, Gagandeep Singh, Andreas Kakolyris, Mohammad Sadrosadati, Jisung Park, and Onur Mutlu, **"Harmonia: A Multi-Agent Reinforcement Learning Approach to Data Placement and Migration in Hybrid Storage Systems"** arXiv preprint, March 2025.
- F. Nisa Bostancı, Oğuzhan Canpolat, Ataberk Olgun, İsmail Emir Yüksel, Konstantinos Kanellopoulos, Mohammad Sadrosadati, A. Giray Yağlıkçı, and Onur Mutlu, **"Understanding and Mitigating Covert Channel and Side Channel Vulnerabilities Introduced by RowHammer Defenses"** Proceedings of the 58th IEEE/ACM International Symposium on Microarchitecture (MICRO), March 2025.
- William Andrew Simon, Irem Boybat, Riselda Kodra, Elena Ferro, Gagandeep Singh, Mohammed Alser, Shubham Jain, Hsinyu Tsai, Geoffrey W. Burr, Onur Mutlu, and Abu Sebastian, **"CIMBA: Accelerating Genome Sequencing through On-Device Basecalling via Compute-in-Memory"** IEEE Transactions on Parallel and Distributed Systems, March 2025.
- Yintao He, Haiyu Mao, Christina Giannoula, Mohammad Sadrosadati, Juan Gómez-Luna, Huawei Li, Xiaowei Li, Ying Wang, and Onur Mutlu, **"PAPI: Exploiting Dynamic Parallelism in Large Language Model Decoding with a Processing-In-Memory-Enabled Computing System"** Proceedings of the 30th ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), March 2025.
- Yufeng Gu, Alireza Khadem, Sumanth Umesh, Ning Liang, Xavier Servot, Onur Mutlu, Ravi Iyer, and Reetuparna Das, **"PIM Is All You Need: A CXL-Enabled GPU-Free System for Large Language Model Inference"** Proceedings of the 30th ACM International Conference on Architectural Support for Programming Languages and Operating Systems, Volume 2 (ASPLOS'25), March 2025.

- Ataberk Olgun, F. Nisa Bostanci, Ismail Emir Yuksel, Oguzhan Canpolat, Haocong Luo, Geraldo F. Oliveira, A. Giray Yaglikci, Minesh Patel, and Onur Mutlu, "**Variable Read Disturbance: An Experimental Analysis of Temporal Variation in DRAM Read Disturbance**" Proceedings of the 31st IEEE International Symposium on High-Performance Computer Architecture (HPCA-31), March 2025.
- Yu Liang, Aofeng Shen, Chun Jason Xue, Riwei Pan, Haiyu Mao, Nika Mansouri Ghiasi, Qingcai Jiang, Rakesh Nadig, Lei Li, Rachata Ausavarungrun, Mohammad Sadrosadati, and Onur Mutlu, "**Ariadne: A Hotness-Aware and Size-Adaptive Compressed Swap Technique for Fast Application Relaunch and Reduced CPU Usage on Mobile Devices**" Proceedings of the 31st IEEE International Symposium on High-Performance Computer Architecture (HPCA-31), March 2025.
- Oğuzhan Canpolat, A. Giray Yağlıkçı, Geraldo F. Oliveira, Ataberk Olgun, Nisa Bostancı, İsmail Emir Yüksel, Haocong Luo, Oğuz Ergin, and Onur Mutlu, "**Chronus: Understanding and Securing the Cutting-Edge Industry Solutions to DRAM Read Disturbance**" Proceedings of the 31st IEEE International Symposium on High-Performance Computer Architecture (HPCA-31), March 2025.
- Yahya Can Tuğrul, A. Giray Yağlıkçı, İsmail Emir Yüksel, Ataberk Olgun, Oğuzhan Canpolat, Nisa Bostancı, Mohammad Sadrosadati, Oğuz Ergin, and Onur Mutlu, "**Understanding RowHammer Under Reduced Refresh Latency: Experimental Analysis of Real DRAM Chips and Implications on Future Solutions**" Proceedings of the 31st IEEE International Symposium on High-Performance Computer Architecture (HPCA-31), February 2025.
- Shaopeng Liu, Judith S Rodriguez, Viorel Munteanu, Cynthia Ronkowski, Nitesh Kumar Sharma, Mohammed Alser, Francesco Andreade, Ran Blekhman, Dagmara Błaszczuk, Rayan Chikhi, Keith A Crandall, Katja Della Libera, Dallace Francis, Alina Frolova, Abigail Shahar Gancz, Naomi E Huntley, Pooja Jaiswal, Tomasz Kosciolk, Pawel P Łabaj, Wojciech Łabaj, Tu Luan, Christopher Mason, Ahmed M Moustafa, Harihara Subrahmaniam Muralidharan, Onur Mutlu, Nika Mansouri Ghiasi, Ali Rahnavard, Fengzhu Sun, Shuchang Tian, Braden T Tierney, Emily Van Syoc, Riccardo Vicedomini, Joseph P Zackular, Alex Zelikovsky, Kinga Zielińska, Erika Ganda, Emily R Davenport, Mihai Pop, David Koslicki, Serghei Mangul, "**Analysis of metagenomic data**" Nature Reviews Methods Primers 1(5), January 2025.
- Mohammed Alser, Julien Eudine, Onur Mutlu, "**Taming large-scale genomic analyses via sparsified genomics**", Nature Communications 1(18), January 2025.
- Furkan Eris, Ulysse McConnell, Can Firtina, Onur Mutlu, "**RawBench: A Comprehensive Benchmarking Framework for Raw Nanopore Signal Analysis Techniques**" bioRxiv preprint, 2025.
- Milan Jain, Burcu O. Mutlu, Caleb Stam, Jan Strube, Brian A. Schupbach, Jason M. St. John, and William A. Pellico, "**AI-Enabled Operations at Fermi Complex: Multivariate Time Series Prediction for Outage Prediction and Diagnosis**" AAAI Workshop on AI for Time Series Analysis, January 2025.
- Joël Lindegger, Can Firtina, Nika Mansouri Ghiasi, Mohammad Sadrosadati, Mohammed Alser, Onur Mutlu, "**Rawalign: Accurate, fast, and scalable raw nanopore signal mapping via combining seeding and alignment**" IEEE Access, December 2024.
- Christina Giannoula, Peiming Yang, Ivan Fernandez, Jiacheng Yang, Sankeerth Durvasula, Yu Xin Li, Mohammad Sadrosadati, Juan Gomez Luna, Onur Mutlu, Gennady Pekhimenko, "**PyGim: An Efficient Graph Neural Network Library for Real Processing-In-Memory Architectures**" Proceedings of the ACM on Measurement and Analysis of Computing Systems 8(3), December 2024.

- Minesh Patel, Taha Shahroodi, Aditya Manglik, A Giray Yağlıkçı, Ataberk Olgun, Haocong Luo, Onur Mutlu, **"Rethinking the Producer-Consumer Relationship in Modern DRAM-Based Systems"** IEEE Access, December 2024
- Onur Mutlu, Ataberk Olgun, Geraldo F. Oliveira, and Ismail Emir Yuksel, **"Memory-Centric Computing: Recent Advances in Processing-in-DRAM"** Invited Paper in Proceedings of the IEEE International Electron Devices Meeting (IEDM), December 2024.
- Georgia Antoniou, Davide Bartolini, Haris Volos, Marios Kleanthous, Zhe Wang, Kleovoulos Kalaitzidis, Tom Rollet, Ziwei Li, Onur Mutlu, Yiannakis Sazeides, Jawad Haj Yahya, **"Agile C-states: a core C-state architecture for latency critical applications optimizing both transition and cold-start latency"** ACM Transactions on Architecture and Code Optimization 21(4), November 2024.
- Shai Bergman, Onur Mutlu, Wu Yong, Keji Huang, Ji Zhang, **"Composable Storage Servers: A Storage Paradigm for Disaggregated Systems"** Proceedings of International Conference on Networking, Architecture and Storage (NAS), November 2024.
- Oğuzhan Canpolat, A Giray Yağlıkçı, Ataberk Olgun, Ismail Emir Yuksel, Yahya Can Tuğrul, Konstantinos Kanellopoulos, Oğuz Ergin, Onur Mutlu, **"Breakhammer: Enhancing rowhammer mitigations by carefully throttling suspect threads"** 57th IEEE/ACM International Symposium on Microarchitecture (MICRO), November 2024.
- Hasan Hassan, Ataberk Olgun, A Giray Yağlıkçı, Haocong Luo, Onur Mutlu, **"Self-Managing DRAM: a low-cost framework for enabling autonomous and efficient DRAM maintenance operations"** Proceedings of the 57th IEEE/ACM International Symposium on Microarchitecture (MICRO), November 2024.
- Alejandro Alonso-Marín, Ivan Fernandez, Quim Aguado-Puig, Juan Gómez-Luna, Santiago Marco-Sola, Onur Mutlu, Miquel Moreto, **"BIMSA: accelerating long sequence alignment using processing-in-memory"**, Bioinformatics 40(11), November 2024.
- Meryem Banu Cavlak, Gagandeep Singh, Mohammed Alser, Can Firtina, Joël Lindegger, Mohammad Sadrosadati, Nika Mansouri Ghiasi, Can Alkan, Onur Mutlu, **"Targetcall: Eliminating the wasted computation in basecalling via pre-basecalling filtering"** Frontiers in Genetics (15), October 2024.
- Can Firtina, Maximilian Mordig, Harun Mustafa, Sayan Goswami, Nika Mansouri Ghiasi, Stefano Mercoglian, Furkan Eris, Joël Lindegger, Andre Kahles, and Onur Mutlu, **"Rawsample: Overlapping and Assembling Raw Nanopore Signals using a Hash-based Seeding Mechanism"** arXiv preprint, October 2024.
- Steve Rhyner, Haocong Luo, Juan Gómez-Luna, Mohammad Sadrosadati, Jiawei Jiang, Ataberk Olgun, Harshita Gupta, Ce Zhang, Onur Mutlu, **"PIM-Opt: Demystifying Distributed Optimization Algorithms on a Real-World Processing-In-Memory System"**, Proceedings of the 2024 International Conference on Parallel Architectures and Compilation Techniques, October 2024.
- Harisankar Sadasivan, Artur Klauser, Juergen Hench, Yatish Turakhia, Gagandeep Singh, Alberto Zeni, Sarah Beecroft, Satish Narayanasamy, Jeff Nivala, Bob Robey, Onur Mutlu, Kristof Denolf, Sriranjani Sitaraman, **"The Genomic Computing Revolution: Defining the Next Decades of Accelerating Genomics"** 2024 IEEE High Performance Extreme Computing Conference (HPEC), September 2024.

- Adnan Mehonic, Daniele Ielmini, Kaushik Roy, Onur Mutlu, Shahar Kvatinsky, Teresa Serrano-Gotarredona, Bernabe Linares-Barranco, Sabina Spiga, Sergey Savel'ev, Alexander G Balanov, Nitin Chawla, Giuseppe Desoli, Gerardo Malavena, Christian Monzio Compagnoni, Zhongrui Wang, J Joshua Yang, Syed Ghazi Sarwat, Abu Sebastian, Thomas Mikolajick, Stefan Slesazeck, Beatriz Noheda, Bernard Dieny, Tuo-Hung Alex Hou, Akhil Varri, Frank Brücknerhoff-Plückelmann, Wolfram Pernice, Xixiang Zhang, Sebastian Pazos, Mario Lanza, Stefan Wiefels, Regina Dittmann, Wing H Ng, Mark Buckwell, Horatio RJ Cox, Daniel J Mannion, Anthony J Kenyon, Yingming Lu, Yuchao Yang, Damien Querlioz, Louis Hutin, Elisa Vianello, Sayeed Shafayet Chowdhury, Piergiulio Mannocci, Yimao Cai, Zhong Sun, Giacomo Pedretti, John Paul Strachan, Dmitri Strukov, Manuel Le Gallo, Stefano Ambrogio, Ilia Valov, Rainer Waser, **"Roadmap to neuromorphic computing with emerging technologies"**, APL Materials 12(10), October 2024.
- Ataberk Olgun, F Nisa Bostanci, Geraldo Francisco de Oliveira Junior, Yahya Can Tugrul, Rahul Bera, Abdullah Giray Yaglikci, Hasan Hassan, Oguz Ergin, Onur Mutlu, **"Sectored dram: A practical energy-efficient and high-performance fine-grained dram architecture"**, ACM Transactions on Architecture and Code Optimization 21(3), September 2024.
- Hajar Falahati, Mohammad Sadrosadati, Qiumin Xu, Juan Gómez-Luna, Banafsheh Saber Latibari, Hyeran Jeon, Shaahin Hesaabi, Hamid Sarbazi-Azad, Onur Mutlu, Murali Annavaram, Masoud Pedram, **"Cross-core data sharing for energy-efficient GPUs"** ACM Transactions on Architecture and Code Optimization 21(3), September 2024.
- Mohammed Alser, Brendan Lawlor, Richard J Abdill, Sharon Waymost, Ram Ayyala, Neha Rajkumar, Nathan LaPierre, Jaqueline Brito, André M Ribeiro-dos-Santos, Nour Almadhoun, Varuni Sarwal, Can Firtina, Tomasz Osinski, Eleazar Eskin, Qiyang Hu, Derek Strong, Byoung-Do Kim, Malak S Abedalthagafi, Onur Mutlu, Serghei Mangul, **"Packaging and containerization of computational methods"** Nature Protocols 19(9), September 2024.
- Jeremie S Kim, Can Firtina, Meryem Banu Cavlak, Damla Senol Cali, Nastaran Hajinazar, Mohammed Alser, Can Alkan, Onur Mutlu, **"AirLift: a fast and comprehensive technique for remapping alignments between reference genomes"** IEEE/ACM Transactions on Computational Biology and Bioinformatics, August 2024.
- Maciej Besta, Robert Gerstenberger, Patrick Iff, Pournima Sonawane, Juan Gómez Luna, Raghavendra Kanakagiri, Rui Min, Grzegorz Kwaśniewski, Onur Mutlu, Torsten Hoefler, Raja Appuswamy, and Aidan O Mahony, **"Hardware Acceleration for Knowledge Graph Processing: Challenges & Recent Developments"** arXiv preprint, August 2024.
- Can Firtina, Melina Soysal, Joël Lindegger, Onur Mutlu, **"RawHash2: mapping raw nanopore signals using hash-based seeding and adaptive quantization"** Bioinformatics 40(8), August 2024.

SAFARI Live Seminars

18

The **SAFARI Live** series of seminars and workshops brings together the world's experts in Computer Architecture to ETH Zurich. The seminars have been ongoing since 2019 and all talks since 2021 is available on our [YouTube Channel](#). We have had the honor to host the following Live seminars this past year. Click on title to watch the talk or check out the [complete 2024-2025 series](#).

SAFARI-EFCL Seminar in Computer Architecture

Serverless on Servers from the Top Down



SPEAKER
Boris Grot
School of Informatics, University of
Edinburgh



ETH zürich

SAFARI

OCT 1, 2025 2:00PM CEST

SAFARI Live Seminars in Computer Architecture

PyGim: An Efficient Graph Neural Network Library for Real Processing-In-Memory Architecture



SPEAKER
Christina Giannoula
University of Toronto & Max Planck
Institute for Software Systems



ETH zürich

SAFARI

SEPT 23, 2025 5:00PM CEST

SAFARI-EFCL Joint Seminar

Algorithms, Software, and Hardware Accelerators for the Next Wave of Genomic Data



SPEAKER
Yatish Turakhia
University of California San Diego



JUNE 18, 2025 10:00AM CEST

SAFARI-EFCL Joint Seminar

Scalable Bioinformatics for Population-Scale Adaptive Immune Receptor Repertoire Analysis



SPEAKER
Serghei Mangul
University of Southern California



JUNE 5, 2025 11:00AM CEST

SAFARI Live Seminars in Computer Architecture

PIM Is All You Need: A CXL- Enabled GPU-Free System for Large Language Model Inference



SPEAKER
Yufeng Gu
University of Michigan



JUNE 5, 2025 3PM CEST

SAFARI Live Seminars in Computer Architecture

CIPHERMATCH: Accelerating Homomorphic Encryption-Based String Matching via Memory- Efficient Data Packing and In-Flash Processing



SPEAKER
Mayank Kabra
SAFARI Research Group, ETH Zurich



JUNE 3, 2025 5:00PM CEST

SAFARI-EFCL Joint Seminar

Analog Computing-In-Memory: Beyond DNN Acceleration



SPEAKER
Saibal Mukhopadhyay
Georgia Institute of Technology



JUNE 2, 2025 11:00AM CEST

SAFARI Live Seminars in Computer Architecture

Beneath the Surface: The Microarchitecture Story of High-Performance and Secure Processors



SPEAKER
Biswabandan Panda
IIT Bombay



MAY 30, 2025 4:30PM CEST

SAFARI Live Seminars

19

The **SAFARI Live** series of seminars and workshops brings together the world's experts in Computer Architecture to ETH Zurich. The seminars have been ongoing since 2019 and all talks since 2021 is available on our [YouTube Channel](#). We are happy to invite speakers for a live seminar, so please [get in touch](#) if you're interested in giving a talk. Click on the thumbnails to watch the talk.

SAFARI-EFCL Joint Seminar

Scalable, Efficient and Real-time Analysis of Long-read Genomic Data



SPEAKER
Hasindu Gamaarachchi
UNSW Sydney



MAY 27, 2025 10:00 CEST

SAFARI-EFCL Joint Seminar

The Best Defense is a Good Offense: Robustly Mitigating Spectre and Rowhammer in Future Systems



SPEAKER
Gururaj Saileshwar
University of Toronto



MAY 27, 2025 17:30 CEST

SAFARI Live Seminars in Computer Architecture

PIMDAL: Mitigating the Memory Bottleneck in Data Analytics using a Real Processing-in-Memory System



SPEAKER
Manos Frouzakis
SAFARI Research Group, ETH Zurich



SAFARI Research Group

MAY 20, 2025 5:00PM CEST

SAFARI Live Seminars in Computer Architecture

PIM-Opt: Demystifying Distributed Optimization Algorithms on a Real-World Processing-In-Memory System



SPEAKER
Steve Rhyner
SAFARI Research Group, ETH Zurich



SAFARI Research Group

JAN 17, 2025 5:00PM CET

SAFARI Live Seminars in Computer Architecture

Accelerated systems for long-read DNA alignment



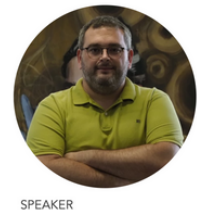
SPEAKER
Hari Sadasivan
AMD AI Group &
University of Washington



NOVEMBER 27, 2024 5PM CET

SAFARI Live Seminars in Computer Architecture

Multiscale modelling for personalised medicine



SPEAKER
ARNAU Montagud
I2SysBio CSIC-UV and
Barcelona Supercomputing Center



NOV 12, 2024 11AM CET

SAFARI-EFCL Seminar

Unlocking the Power of Mixed-Precision Spatial Compute in the AMD Ryzen™ AI NPU



SPEAKERS
Gagandeep Singh, Kristof Denolf, Alireza Khodamoradi
AMD, Research and Advanced Development Group



OCT 22, 2024 1:00PM CEST

SAFARI Live Seminars in Computer Architecture

Exploiting RowPress and RowHammer and How To Defend Against It



SPEAKER
Jonas Juffinger
IAIK, TU Graz



JULY 16, 2024 2:00PM CEST

Tutorials & Workshops

20

1st SAFARI Live Workshop (SaLWo)

a four-day workshop at ETH Zurich, where SAFARI and affiliated researchers share their cutting edge research in four main focus areas:

- Memory Robustness
- Health Applications
- Data-Centric and Energy-Efficient Computing
- Storage Systems

SAFARI Live Workshops in Computer Architecture

1st SAFARI Live Workshop (SaLWo) 2025
Day 4: Storage Systems

Speakers: Andreas Kosmas, Rakesh Nadig, Mayank Kabra, Gagandeep Singh, Konstantina Kologeorgi, Nika Mansouri Ghiasi.

Friday, Sept 19 2025
8:30-18:00 CEST
ETH Zurich, ETZ E81 & online

ETH zürich | SAFARI

scan for the program

VIRTUOSO

Infrastructure for Evaluating
Novel HW/OS Interfaces

MICRO 2025 Workshop & Tutorial

Organizers: Konstantinos Kanellopoulos, Onur Mutlu
Tutorial Support: Konstantinos Sgouras, Harsh Songara

SAFARI ETH zürich

VIRTUOSO - Infrastructure for Evaluating Novel HW/OS Interfaces

MICRO 2025 Conference in Seoul, South Korea

a full-day workshop and tutorial on the principles, methodologies, and practical aspects of hardware/OS co-design for memory management

- Workshop Details
- Watch YouTube Livestream

First Workshop on Architecture for Health (Arch4Health)

MICRO 2025 Conference in Seoul, South Korea

A half-day workshop exploring the key computational challenges in health-related applications and the vital role of computer architecture in overcoming them to advance healthcare

- Workshop Details
- Watch YouTube Livestream

First Workshop on Architecture for Health

Arch4Health

A half-day workshop @ MICRO 2025

exploring the key computational challenges
in health-related applications
and the vital role of computer architecture
in overcoming them

18th (Saturday) October 2025, Seoul, Korea
<https://events.safari.ethz.ch/micro25-arch4health/>

More Information
and Call
for Presentations:

QR code

ISCA 2025 - 3rd Workshop on
Memory-Centric Computing Systems

Saturday, 21st June, 2025, Tokyo, Japan

Organizers: Geraldo F. Oliveira, Dr. Mohammad Sadrosadati, Ataberk Olgun, Professor Onur Mutlu
Program: <https://events.safari.ethz.ch/isca25-MCCSys/doku.php>

Overview of PIM | PIM taxonomy
PIM in memory & storage
Real-world PNM systems
PUM for bulk bitwise operations
Programming techniques & tools
Infrastructures for PIM Research
Research challenges & opportunities

ISCA 2025
June 21 - 25, 2025
Tokyo, Japan

QR code

3rd Workshop on Memory-Centric Computing Systems (MCCSys)

ISCA 2025 Conference in Tokyo, Japan

a combined tutorial and workshop focusing on the latest advances in Processing-in-Memory (PIM) technology, spanning both hardware and software

- Workshop Details
- Watch YouTube Livestream

Tutorials & Workshops

21

ICS 2025 - 2nd Workshop on Memory-Centric Computing Systems

Sunday, June 8th, Salt Lake City, USA

Organizers: Geraldo F. Oliveira, Dr. Mohammad Sadrosadati, Ataberk Olgun, Professor Onur Mutlu
Program: <https://events.safari.ethz.ch/ics25-MCCSys/doku.php>



Overview of PIM | PIM taxonomy
PIM in memory & storage
Real-world PNM systems
PUM for bulk bitwise operations
Programming techniques & tools
Infrastructures for PIM Research
Research challenges & opportunities



2nd Workshop on Memory-Centric Computing Systems (MCCSys)

ICS 2025 Conference in Salt Lake City, USA

a combined tutorial and workshop focusing on the latest advances in Processing-in-Memory (PIM) technology, spanning both hardware and software

- [Workshop Details](#)
- Watch [YouTube Livestream](#)

1st Workshop on Memory-Centric Computing Systems (MCCSys)

ASPLOS 2025 Conference in Rotterdam, Netherlands

a combined tutorial and workshop focusing on the latest advances in Processing-in-Memory (PIM) technology, spanning both hardware and software

- [Workshop Details](#)
- Watch [YouTube Livestream](#)

ASPLOS 2025 - 1st Workshop on Memory-Centric Computing Systems

Sunday, March 30th, Rotterdam, The Netherlands

Organizers: Geraldo F. Oliveira, Dr. Mohammad Sadrosadati, Ataberk Olgun, Professor Onur Mutlu
Program: <https://events.safari.ethz.ch/asplos25-MCCSys/doku.php>



Overview of PIM | PIM taxonomy
PIM in memory & storage
Real-world PNM systems
PUM for bulk bitwise operations
Programming techniques & tools
Infrastructures for PIM Research
Research challenges & opportunities



Tutorial on Memory-Centric Computing Systems

PPoPP 2025 Conference in Las Vegas, USA

- This tutorial focuses on the latest hw/sw advances in PIM technology (including novel PIM ideas, research tools and frameworks andnd programming and optimization kernel strategies.

- [Workshop Details](#)
- Watch [YouTube Livestream](#)

PPoPP 2025 - Tutorial on Memory-Centric Computing Systems

March 1st, Las Vegas, Nevada, USA

Organizers: Geraldo F. Oliveira, Dr. Mohammad Sadrosadati, Ataberk Olgun, Professor Onur Mutlu
Program: <https://events.safari.ethz.ch/ppopp25-memorycentric-tutorial/>



Overview of PIM | PIM taxonomy
PIM in memory & storage
Real-world PNM systems
PUM for bulk bitwise operations
Programming techniques & tools
Infrastructures for PIM Research
Research challenges & opportunities



Processing-in-Memory (PIM)

Tutorials: Experiences from Past Two Years and Thoughts Looking Forward

PIM transitioned from theory to commercial reality, a shift we chronicled through our hands-on 2023-2025 tutorial series at major conferences such as ISCA, ASPLOS, MICRO, and HPCA. In this [article](#), Geraldo Oliveira et al., share their experience of hosting these sessions, and extends an invitation to researchers to access our open-source course materials and YouTube livestreams to help drive the software-hardware co-design needed for future memory-centric systems. Read [article](#)



well-attended PIM tutorial at MICRO 2024



Our Commitment

We are committed to democratizing education through our regular posting of course lectures and talk videos online. We livestream lectures and talks on YouTube and make all media and material freely available on both our course website and YouTube channels. Our **YouTube Channels** have tens of thousands of subscribers, and our online materials are used by students, universities, and industry leaders over the globe. We are particularly dedicated to sharing our resources with those without access to state-of-the-art computer architecture classes.



Onur Mutlu Lectures

@OnurMutluLectures · 57.3K subscribers · 1.5K videos

This channel contains videos and slides from courses taught at people.inf.ethz.ch/omutlu and 3 more links

[Subscribe](#)

Home Videos Live Courses Playlists Posts

Popular videos

How Computers Work (from the ground up)

1:33:25

Digital Design & Computer Architecture: Lecture 1:...

174K views · 5 years ago

Computer Architecture - Lecture 1: Introduction and...

2:39:20

Computer Architecture - Lecture 1: Introduction and...

89K views · 5 years ago

Design of Digital Circuits - Lecture 1: Introduction and...

1:22:29

Design of Digital Circuits - Lecture 1: Introduction and...

68K views · 6 years ago

Channel Stats

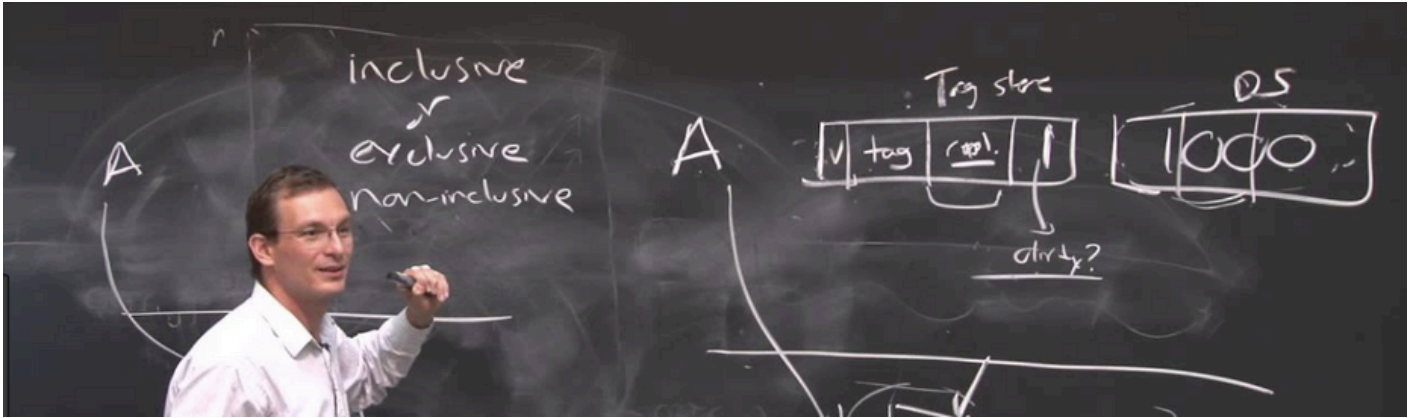
4.5M
Views

57.3K
Subscribers

1.5K
Videos

8
Years of Access

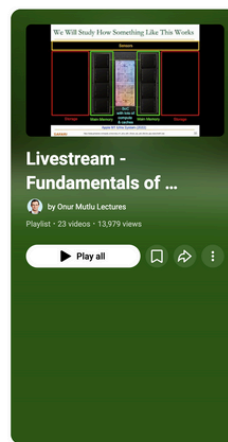
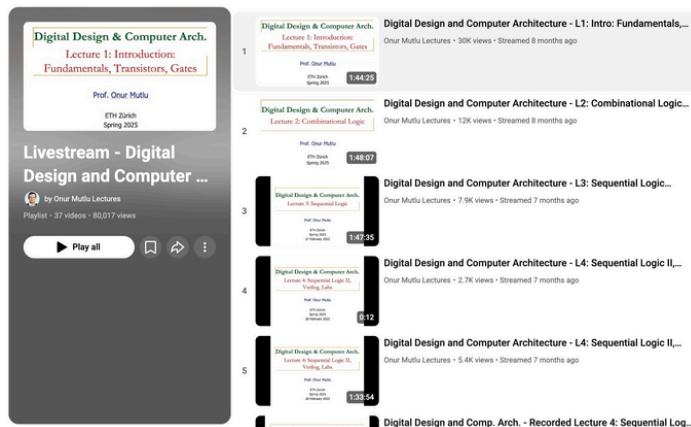
Our Courses



Fundamentals of Computer Architecture

This course covers modern processor architectures, state-of-the-art accelerators (e.g., GPUs, systolic arrays, ML accelerators), and memory systems (caches, main memory, storage), with a focus on both fundamentals and research.

- Spring 2025 [Course Website](#)
- Spring 2025 [Lecture Videos](#) (YouTube)



Digital Design and Computer Architecture

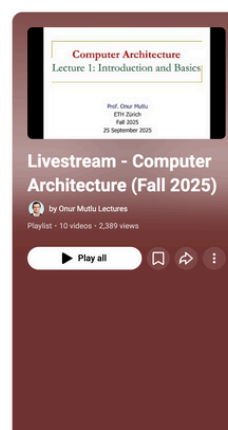
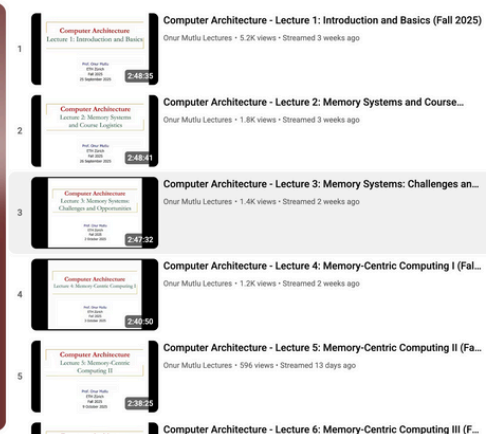
Digital Design and Computer Architecture is a 2nd semester bachelor course that gives a rigorous introduction into "How Computers Work" and hands-on FPGA lab assignments.

- Spring 2025 [Course Website](#)
- Spring 2025 [Lecture Videos](#) (YouTube)

Computer Architecture

Computer Architecture is a critical analysis course taken by Bachelor/Masters/PhD students. We look in-depth at cutting-edge topics, ideas and fundamentals in Computer Architecture, including 20+ lectures, lab assignments and homeworks.

- Fall 2025 [Course Website](#)
- Fall 2025 [Lecture Videos](#) (YouTube)

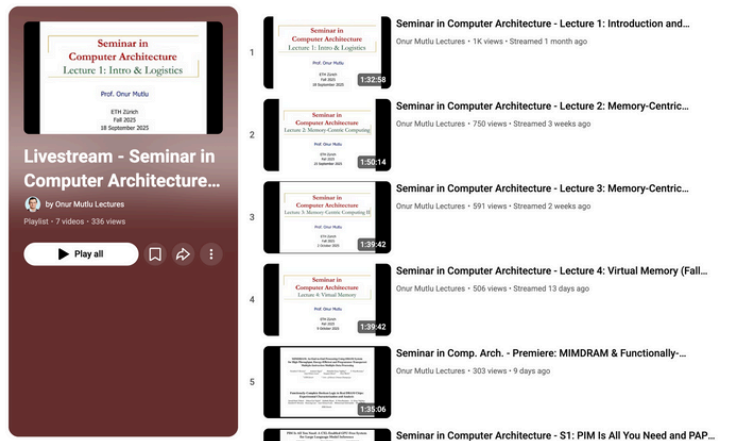


Our Courses

Seminar in Computer Architecture

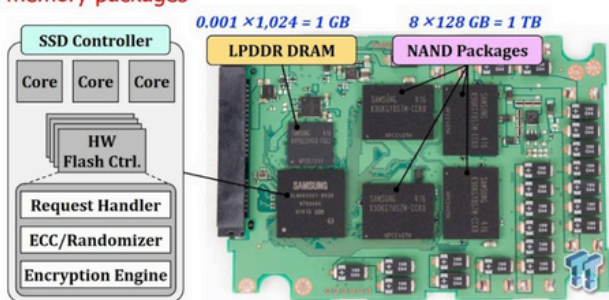
The Seminar in Computer Architecture covers fundamental and cutting-edge research papers in computer architecture. Students learn how to rigorously analyze, present and discuss research papers.

- Fall 2025 [Course Website](#) | [Lecture Videos](#)
- Spring 2025 [Course Website](#) | [Lecture Videos](#)
- Fall 2024 [Course Website](#) | [Lecture Videos](#)



Modern SSD Architecture

- A modern SSD is a **complicated system** that consists of **multiple cores, HW controllers, DRAM, and NAND flash memory packages**



Samsung PM853T 960GB Enterprise SSD (from <https://www.benchmarkreviews.com/reviews/samsung-pm853t-960gb-enterprise-ssd-review/index.html>)

Understanding and Designing Modern Storage Systems

SAFARI Projects & Seminars Course

This course covers the internal architecture and management of modern NAND flash and emerging memory SSDs. You will apply this knowledge by refactoring the MQSim simulator to implement and evaluate advanced storage system optimizations.

- Spring 2025 [Course Website](#)

FPGA-based Exploration of DRAM and RowHammer

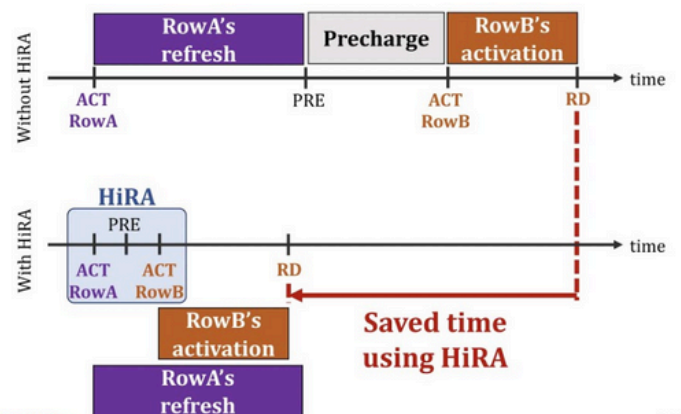
SAFARI Projects & Seminars Course

Students learn how DRAM is organized, operates at a low-level, and gain practical experience in using DRAM Bender while developing DRAM test programs for new DRAM characterization studies related to performance, reliability, and security. Improvements in DRAM Bender infrastructure or the discovery of new security vulnerabilities like RowHammer may be possible through experimentation.

- Spring 2025 [Course Website](#)
- Fall 2024 [Course Website](#)

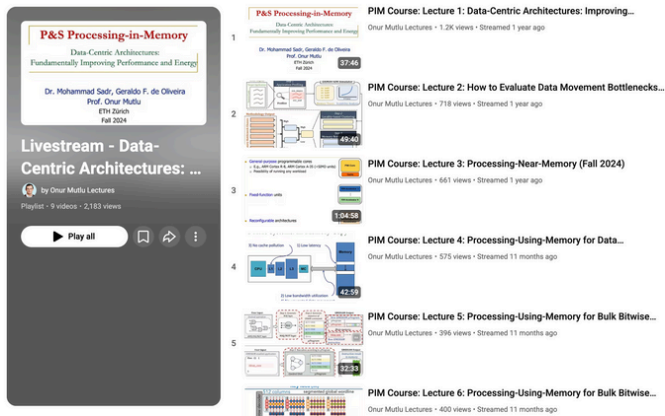
HiRA: Hidden Row Activation

Refresh RowA concurrently with **Activating RowB**



SAFARI

Our Courses



Data-Centric Architectures: Fundamentally Improving Performance and Energy

SAFARI Projects & Seminars Course

In this course, students work hands-on with the first real-world Processing-in-Memory (PIM) architecture, explore various architecture designs for important workloads, and develop tools to enable research of future PIM systems.

- Fall 2024 [Course Website](#) | [Lecture Videos](#)

Exploration of Emerging Memory Systems

SAFARI Projects & Seminars Course

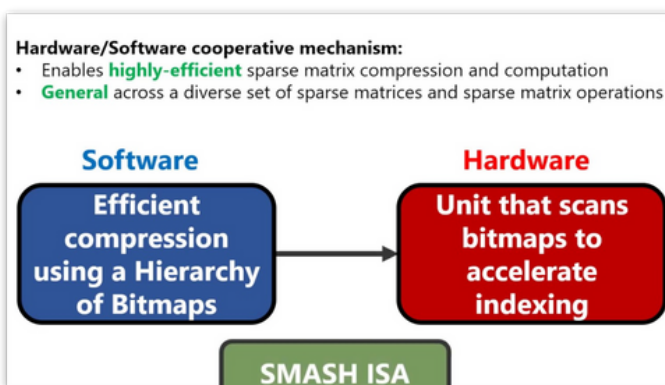
In this course, students design new memory and memory controller mechanisms and extend Ramulator (an extensible main memory simulator) with these new designs and evaluate their performance, energy consumption, and reliability.

- Fall 2024 [Course Website](#)

P&S Ramulator

Designing and Evaluating Memory Systems and Modern Software Workloads with Ramulator

Hasan Hassan
Prof. Onur Mutlu
ETH Zürich



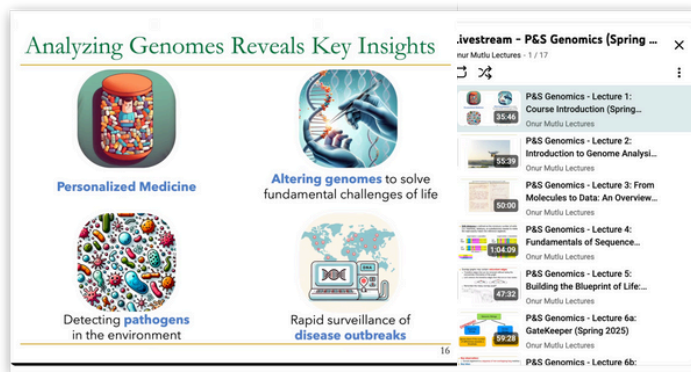
Intelligent Architectures using Hardware/Software Cooperative Techniques

SAFARI Projects & Seminars Course

In this course, students explore hw/sw co-design topics such as: (i) new hw/sw interfaces (e.g., virtual memory, instruction set architecture) to enhance performance, energy and security, (ii) hw/sw co-design schemes to improve the performance of the

memory subsystem in killer memory-intensive applications (e.g., sparse and irregular workloads), (iii) hardware/software cooperative machine-learning-based techniques for different microarchitectural components such as prefetchers, caches and branch predictors, which would continuously learn from the vast amount of memory accesses seen by a processor and adapt to the varying workload and system conditions.

- Fall 2024 [Course Website](#)



Clinical Genomics

SAFARI Projects & Seminars Course

The course covers basics of genome analysis for medical applications, high-throughput diagnostics, and the early detection and prevention of diseases. Students experimentally evaluate different algorithms and machine-learning techniques to uncover somatic mutations in cancer and develop tools dedicated to microbiome discovery and disease diagnostics.

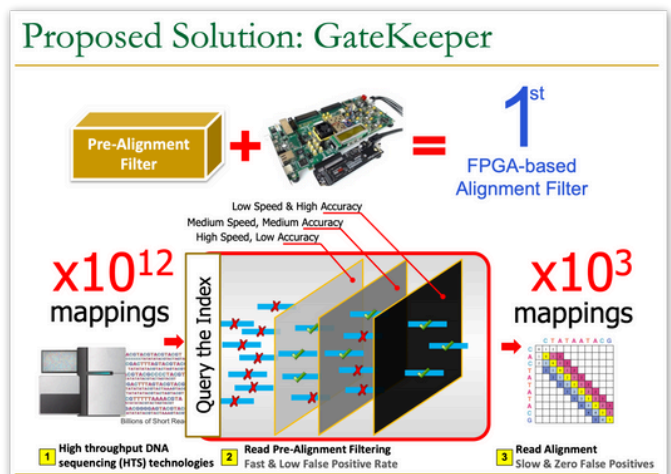
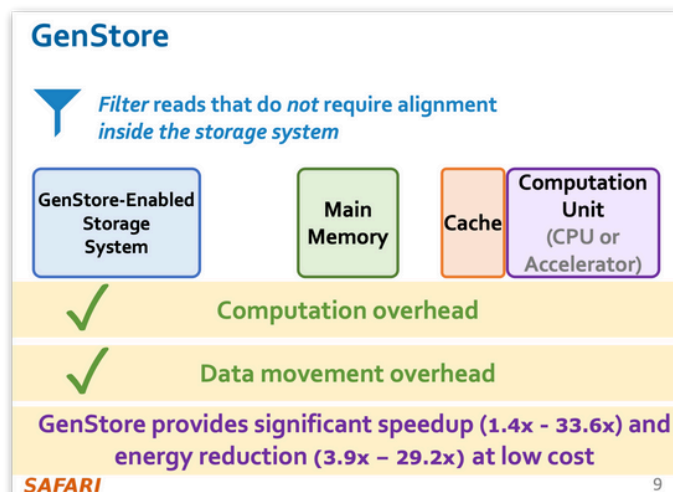
- Fall 2025 [Course Website](#)
- Spring 2025 [Course Website](#) | [Lecture Videos](#)
- Fall 2024 [Course Website](#) | [Lecture Videos](#)

Algorithm and Architecture Design for Genomics

SAFARI Projects & Seminars Course

The course covers how advanced hardware solutions like FPGAs and GPUs can expedite genome analysis by reducing computational time and energy consumption. In parallel, it delves into the use and development of heuristic algorithms & tools for accelerating genome analysis across various computational platforms.

- Spring 2025 [Course Website](#) | [Lecture Videos](#)
- Fall 2024 [Course Website](#)



Accelerating Genome Analysis

SAFARI Projects & Seminars Course

This course explores how to accelerate genome analysis by using both advanced hardware, like FPGAs and GPUs, and developing efficient heuristic algorithms. Through hands-on projects, students will optimize existing methods and create new tools, gaining a holistic view of the field's current challenges and solutions.

- Spring 2025 [Course Website](#)
- Fall 2024 [Course Website](#)

Our Partners

27



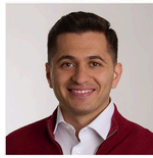
We thank our industry partners and funding agencies for their support in 2024 and 2025. Our group was generously supported with new and continuing donations and project funding from AI Chip Center for Emerging Smart Systems (ACCESS), ByteDance, Google, Huawei, Intel, Xilinx, Microsoft, SRC, SNSF and EU Horizon Europe as well as past donations from ASML, Alibaba, VMware. We thank all of our industry partners for their continued support of our research, and partners who have generously supported us with new donations this year, as well as funding support from SNSF and Horizon Europe (and SERI). We also want to thank the [ETH Foundation](#), [ETH Transfer](#) and the [ETH EU GrantsAccess](#) teams for facilitating and supporting our industry relations, projects, and gift funding.

We always welcome new project collaborations, donations and gifts to support our research. Please contact [Prof. Onur Mutlu](#) for more information on donations and being a SAFARI Research Group supporter.

1st SAFARI Conference 2025



Abdullah Giray
Yağlikçi, CISPA



Can Firtina
University of
Maryland, College
Park



Haiyu Mao
King's College
London



Juan Gómez
Luna, NVIDIA



Christina Giannoula
MPI-SWS



Jawad Haj-
Yahya, Rivos Inc.



Nastaran
Hajinazar
Intel Labs



Lois Orosa
Galicia Supercomputing
Center, CESGA



Yu (Lenny) Liang
Inria Paris



Gagandeep
Singh, AMD



Minesh Patel
Rutgers University



Geraldo Francisco
de Oliveira
ETH Zurich



Saugata Ghose
University of Illinois
Urbana-Champaign

Monday, Dec 15 2025, 8:30-18:30 CET

ETHzürich

SAFARI

Click Image to View the Complete Program

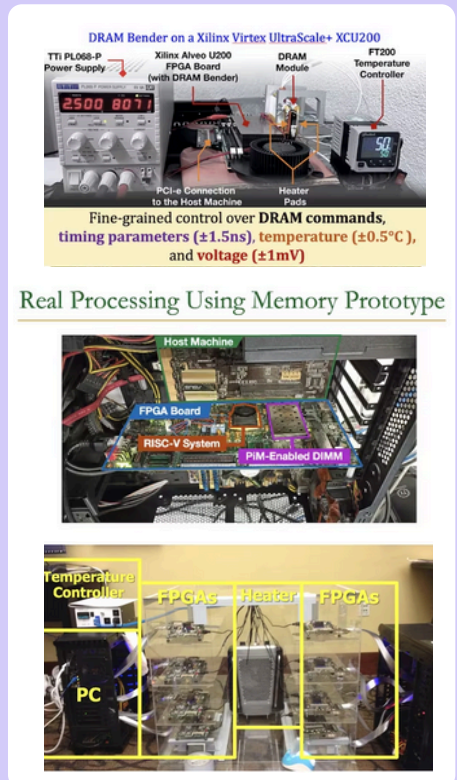
On the 15th of December, we are hosting the inaugural **SAFARI Conference**, a full-day workshop, where former SAFARI researchers reunite and share their cutting-edge research in critical domains, including but not limited to Memory Robustness, Processing-In-Memory and Storage Systems, their intersection with AI applications and accelerators as well as Health Analytics.

Join us in-person at ETH Zurich or online to learn, share, and contribute to shaping the future of computer architecture, data-centric systems and specialized architectures for AI and health analytics.

- Date: December 15, 2025
- Locations: HG D16.2 and ETZ E7, ETH Zurich
- Livestream: [YouTube](#)
- Schedule: View [Program Info](#)



SAFARI Experimental Laboratory

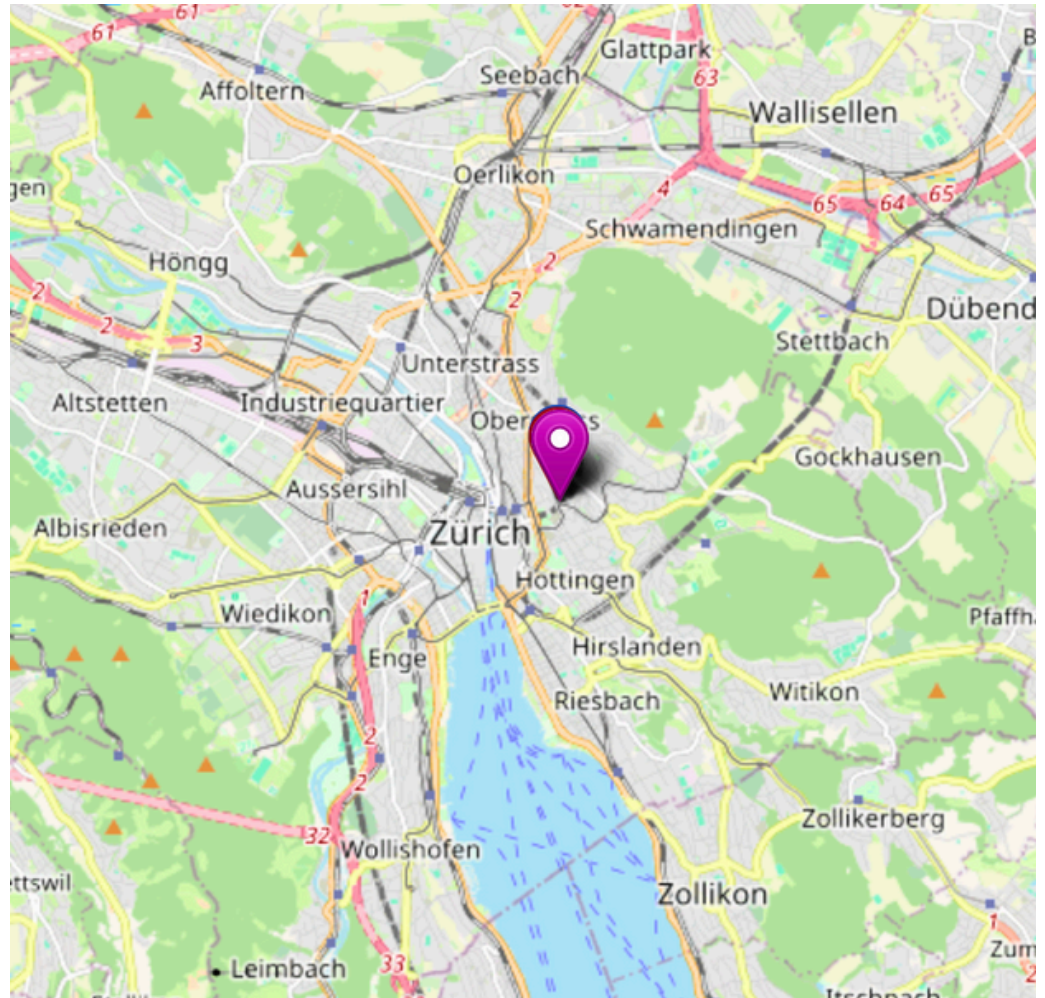


We design and maintain unique cutting-edge hardware infrastructures that enable testing of memory chips (DRAM and flash memory) for reliability, security and performance issues, under various operating conditions (voltage, temperature, workloads). We have built up a comprehensive and one-of-a-kind experimental lab and software-hardware ecosystem to rigorously test and characterize memory chips under controlled conditions. With our open-source FPGA-based memory controllers ([DRAM Bender](#), [PiDRAM](#), [EasyDRAM](#)), our lab represents a unique and evolving testbed for exploring next-generation memory reliability, performance, and security mechanisms. We also design and maintain architecture-level simulation tools, benchmark suites, and bioinformatics software. We open-source these artifacts (such as [Ramulator 2.0](#)), which are widely used by both academia and industry and have led to many independent validations with both high industrial and academic impact. We are pioneers in helping to fundamentally change the design paradigm of computers: to enable computation near data, i.e. Processing-in-Memory (PIM), tackling all aspects of how to enable and design PIM systems: cross-layer research, design, and adoption challenges in devices, architecture, systems, applications and programming models. We will continue our cutting-edge work that has widely and deeply influenced academia and industry and will work closely with industry collaborators to further explore and help enable adoption of novel PIM and other computing paradigms.

Contact Us



SAFARI SAFARI Research Group



Email

Head of Group
Prof. Onur Mutlu
onur.mutlu@safari.ethz.ch

Administration
Tulasi Blake
tulasi.blake@safari.ethz.ch

Scientific Coordination
Dr. Tracy Ewen
tracy.ewen@inf.ethz.ch

Address

ETH Zurich, D-ITET,
Gloriastrasse 35,
8092 Zurich

www.safari.ethz.ch

Follow us on:



Newsletter Design
Dr. Naveen Shamsudhin
n@naveen.cc