

# Steffen Frey

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## Academic Career

since 2020 **Assistant Professor**, *RUG*.  
2014 – 2020 **Postdoctoral Researcher**, *University of Stuttgart, Visualization Research Center (VISUS)*.  
**Visionary Postdoc, SimTech Cluster of Excellence**.  
2008 – 2014 **Dr. rer. nat.**, *VISUS*, date of defense: 07.11.2014, Supervisor: Prof. Thomas Ertl, "Strategies for Efficient Parallel Visualization" (*summa cum laude*).  
**Graduate School Simulation Technology**, *SimTech Cluster of Excellence*.  
2010 & 12 **Visiting Researcher**, *University of California, Davis, USA*, Prof. Kwan-Liu Ma, VIDI Labs.  
2002 – 2008 **Dipl.-Inf.**, *University of Stuttgart*, Computer Science, thesis "GPU-based Cone Beam Reconstruction of Large CT Datasets" in collaboration with Daimler AG.  
2005 – 2006 **Study Abroad**, *University of Kansas, Lawrence, USA*, with Science Scholarship.

## List of Publications (talks at conference as noted; fully peer-reviewed, unless noted otherwise)

- [1] Tkachev, G., **Frey, S.**, Ertl, T., "Local prediction models for spatiotemporal volume visualization," *IEEE Transactions on Visualization and Computer Graphics*, preprint, 2020.
- [2] Bruder, V., Kurzhals, K., **Frey, S.**, Weiskopf, D., Ertl, T., "Space-time volume visualization of gaze and stimulus," *ACM Symposium on Eye Tracking Research & Applications (ETRA)*, 12:1–12:9, 2019.
- [3] Bruder, V., Müller, C., **Frey, S.**, Ertl, T., "On evaluating runtime performance of interactive visualizations," *IEEE Transactions on Visualization and Computer Graphics*, pp. 1–1, 2019.
- [4] Bruder, V., Schulz, C., Bauer, R., **Frey, S.**, Weiskopf, D., Ertl, T., "Voronoi-based foveated volume rendering," *EuroVis - Short Papers*, 2019.
- [5] Fernandes, O., **Frey, S.**, Reina, G., Ertl, T., "Visual representation of region transitions in multi-dimensional parameter spaces," *Smart Tools and Applications in Graphics (STAG)*, 2019.
- [6] Rau, T., Gralka, P., Fernandes, O., Reina, G., **Frey, S.**, Ertl, T., "The impact of work distribution on in situ visualization: A case study," *In Situ Infrastructures for Enabling Extreme-scale Analysis and Visualization (ISAV)*, 12:1–12:9, 2019.
- [7] Tabiai, I., Tkachev, G., Diehl, P., **Frey, S.**, Ertl, T., Therriault, D., Lévesque, M., "Hybrid image processing approach for autonomous crack area detection and tracking using local digital

image correlation results applied to single-fiber interfacial debonding," *Engineering in Fracture Mechanics*, vol. 216, p. 106485, 2019.

- [8] Bruder, V., Hlawatsch, M., **Frey, S.**, Burch, M., Weiskopf, D., Ertl, T., "Volume-Based Large Dynamic Graph Analytics," in *22nd International Conference on Information Visualisation*, 2018.
- [9] **Frey, S.**, "Spatio-Temporal Contours from Deep Volume Raycasting," *Comput. Graph. Forum (EuroVis 2018)*, with talk, 2018.
- [10] Frieß, F., Landwehr, M., Bruder, V., **Frey, S.**, Ertl, T., "Adaptive encoder settings for interactive remote visualisation on high-resolution displays," *Symposium on Large Data Analysis and Visualization (LDAV)*, 2018.
- [11] Hui, Z., **Frey, S.**, Steeb, H., Uribe, D., Ertl, T., Wang, W., "Visualization of bubble formation in porous media," *IEEE Trans. Visual. Comput. Graphics (SciVis 2018)*, 2018.
- [12] Bruder, V., **Frey, S.**, Ertl, T., "Prediction-based load balancing and resolution tuning for interactive volume raycasting," *Visual Informatics*, 2017.
- [13] Bußler, M., Diehl, P., Pflüger, D., **Frey, S.**, Sadlo, F., Ertl, T., Schweitzer, M. A., "Visualization of fracture progression in peridynamics," *Computers and Graphics*, 2017.
- [14] Diehl, P., Bußler, M., Pflüger, D., **Frey, S.**, Ertl, T., Sadlo, F., Schweitzer, M. A., "Extraction of fragments and waves after impact damage in particle-based simulations," in *Meshfree Methods for Partial Differential Equations VIII*, M. Griebel and M. A. Schweitzer, Eds. Cham: Springer International Publishing, 2017, pp. 17–34.
- [15] Fernandes, O., **Frey, S.**, Ertl, T., "Transportation-based visualization of energy conversion," Springer, 2017.
- [16] **Frey, S.**, Ertl, T., "Fast flow-based distance quantification and interpolation for high-resolution density distributions," in *EG 2017 - Short Papers*, with talk, 2017.
- [17] Scharnowski, K., **Frey, S.**, Raffin, B., Ertl, T., "Spline-based decomposition of streamed particle trajectories for efficient transfer and analysis," in *EG 2017 - Short Papers*, 2017.
- [18] Tkachev, G., **Frey, S.**, Müller, C., Bruder, V., Ertl, T., "Prediction of Distributed Volume Visualization Performance to Support Render Hardware Acquisition," in *Eurographics Symposium on Parallel Graphics and Visualization*, The Eurographics Association, 2017.
- [19] **Frey, S.**, Ertl, T., "Progressive direct volume-to-volume transformation," *IEEE Trans. Visual. Comput. Graphics (SciVis 2016)*, vol. 23, no. 1, pp. 921–930, with talk, 2017.
- [20] **Frey, S.**, "Sampling and estimation of pairwise similarity in spatio-temporal data based on neural networks," *Informatics*, vol. 4, no. 27, 2017.
- [21] Bruder, V., **Frey, S.**, Ertl, T., "Real-time performance prediction and tuning for interactive volume raycasting," in *SIGGRAPH ASIA 2016 Symposium on Visualization*, ser. SA '16, Macau: ACM, 2016, 7:1–7:8.
- [22] Fernandes, O., **Frey, S.**, Ertl, T., "Interpolation-based extraction of representative isosurfaces," in *Lecture Notes in Computer Science*, 2016.
- [23] **Frey, S.**, Ertl, T., "Auto-tuning intermediate representations for in situ visualization," in *2016 New York Scientific Data Summit (NYSDS)*, with talk, abstract review only, 2016, pp. 1–10.
- [24] **Frey, S.**, Ertl, T., "Flow-based temporal selection for interactive volume visualization," *Comput. Graph. Forum*, 2016.
- [25] Schulz, C., Nocaj, A., El-Assady, M., **Frey, S.**, Hlawatsch, M., Hund, M., Karch, G., Netzel, R., Schätzle, C., Butt, M., Keim, D. A., Ertl, T., Brandes, U., Weiskopf, D., "Generative data models for validation and evaluation of visualization techniques," in *Proceedings of the Sixth Workshop on Beyond Time and Errors on Novel Evaluation Methods for Visualization*, ser. BELIV '16, Baltimore, MD, USA: ACM, 2016, pp. 112–124.

- [26] Blom, D. S., Ertl, T., Fernandes, O., **Frey, S.**, Klimach, H., Krupp, V., Mehl, M., Roller, S., Stornel, D. C., Uekermann, B., Winter, T., Van Zuijlen, A. H., "Partitioned fluid-structure-acoustics interaction on distributed data," in *Software for Exascale Computing - SPPEXA 2013-2015*, Springer, Ed., vol. 113, Springer International Publishing, no peer review, 2016, Pages267–291.
- [27] Fernandes, O., Blom, D. S., **Frey, S.**, Van Zuijlen, S. H., Bijl, H., Ertl, T., "On in-situ visualization for strongly coupled partitioned fluid-structure interaction," in *VI International Conference on Computational Methods for Coupled Problems in Science and Engineering*, 2015.
- [28] **Frey, S.**, Sadlo, F., Ertl, T., "Balanced sampling and compression for remote visualization," in *ACM SIGGRAPH Asia 2015 Symposium on Visualization in High Performance Computing*, with talk, 2015.
- [29] Panagiotidis, A., **Frey, S.**, Ertl, T., "Exploratory Performance Analysis and Tuning of Parallel Interactive Volume Visualization on Large Displays," in *EuroVis - Short Papers*, E. Bertini, J. Kennedy, and E. Puppo, Eds., The Eurographics Association, 2015.
- [30] Fernandes, O., **Frey, S.**, Sadlo, F., Ertl, T., "Space-time volumetric depth images for in-situ visualization," in *IEEE Symposium on Large Data Analysis and Visualization*, 2014, pp. 59–65.
- [31] **Frey, S.**, Sadlo, F., Ma, K., Ertl, T., "Interactive progressive visualization with space-time error control," *IEEE Trans. Visual. Comput. Graphics (SciVis 2014)*, vol. 20, no. 12, pp. 2397–2406, with talk, 2014.
- [32] **Frey, S.**, Sadlo, F., Ertl, T., "Explorable volumetric depth images from raycasting," in *Conference on Graphics, Patterns and Images*, with talk, 2013, pp. 123–130.
- [33] **Frey, S.**, Sadlo, F., Ertl, T., "Mesh Generation From Layered Depth Images Using Isosurface Raycasting," in *ISVC '13: Proceedings of the 9th International Symposium on Advances in Visual Computing*, Rethymnon, Crete, Greece: Springer-Verlag, with talk, 2013, pp. 373–383.
- [34] **Frey, S.**, Reina, G., Ertl, T., "Simt microscheduling: Reducing thread stalling in divergent iterative algorithms," in *IEEE Euromicro International Conference on Parallel, Distributed and Network-based Processing*, with talk, 2012, pp. 399–406.
- [35] **Frey, S.**, Sadlo, F., Ertl, T., "Visualization of temporal similarity in field data," *IEEE Trans. Visual. Comput. Graphics (SciVis 2012)*, vol. 18, no. 12, pp. 2023–2032, with talk, 2012.
- [36] Ament, M., **Frey, S.**, Sadlo, F., Ertl, T., Weiskopf, D., "Gpu-based two-dimensional flow simulation steering using coherent structures," in *Proceedings of the Second International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering*, P. Iványi and B. H. V. Topping, Eds., paper 18, Stirlingshire, United Kingdom: Civil-Comp Press, 2011.
- [37] **Frey, S.**, Ertl, T., "Load balancing utilizing data redundancy in distributed volume rendering," in *Eurographics Symposium on Parallel Graphics and Visualization*, with talk, 2011, pp. 51–60.
- [38] **Frey, S.**, Schlömer, T., Grottel, S., Dachsbacher, C., Deussen, O., Ertl, T., "Loose capacity-constrained representatives for the qualitative visual analysis in molecular dynamics," in *IEEE Pacific Visualization Symposium*, with talk, 2011, pp. 51–58.
- [39] Panagiotidis, A., Kauker, D., **Frey, S.**, Ertl, T., "DIANA: A Device Abstraction Framework for Parallel Computations," in *Proceedings of the Second International Conference on Parallel, Distributed, Grid and Cloud Computing for Engineering*, Stirlingshire, United Kingdom: Civil-Comp Press, 2011.
- [40] **Frey, S.**, Ertl, T., "PaTraCo: A Framework Enabling the Transparent and Efficient Programming of Heterogeneous Compute Networks," in *EGPGV, Norrköping, Sweden*, Eurographics Association, with talk, 2010, pp. 131–140.
- [41] Kauker, D., Sanftmann, H., **Frey, S.**, Ertl, T., "Memory Saving Fourier Transform on GPUs," in *International Conference on Computer and Information Technology*, IEEE, 2010, pp. 67–75.

- [42] Üffinger, M., **Frey, S.**, Ertl, T., “Interactive high-quality visualization of higher-order finite elements,” *Comput. Graphics Forum (Eurographics 2010)*, vol. 29, no. 2, pp. 337–346, 2010.
- [43] **Frey, S.**, Ertl, T., “Accelerating Raycasting Utilizing Volume Segmentation of Industrial CT Data,” in *EG UK Theory and Practice of Computer Graphics, Cardiff University, United Kingdom, 2009.*, W. Tang and J. P. Collomosse, Eds., Eurographics Association, with talk, 2009, pp. 33–40.
- [44] **Frey, S.**, Müller, C., Strengert, M., Ertl, T., “Concurrent ct reconstruction and visual analysis using hybrid multi-resolution raycasting in a cluster environment,” in *Proceedings of the 5th International Symposium on Advances in Visual Computing: Part I*, ser. ISVC '09, Las Vegas, Nevada: Springer-Verlag, with talk, 2009, pp. 357–366.
- [45] Müller, C., **Frey, S.**, Strengert, M., Dachsbacher, C., Ertl, T., “A compute unified system architecture for graphics clusters incorporating data locality,” *IEEE Trans. Visual. Comput. Graphics*, vol. 15, no. 4, pp. 605–617, 2009.

## Paper Awards

- 2019 **Winner**, *Scientific Visualization Contest 2019 (VIS 2019)*, “Visual Analysis of Structure Formation in Cosmic Evolution”.
- Honorable Mention**, *In Situ Infrastructures for Enabling Extreme-scale Analysis and Visualization (in conjunction with SC19)*, “The Impact of Work Distribution on In Situ Visualization: A Case Study” [6].
- Best Paper**, *EuroVis (Short Papers)*, “Voronoi-Based Foveated Volume Rendering” [4].
- 2018 **Best Paper**, *International Conference on Information Visualisation*, “Volume-Based Large Dynamic Graph Analytics” [8].

## Acquisition of Research Funding

- 2019 **Machine Learning for Data-driven Visualization (ML4Vis)**, *Principal Investigator*, funded project within the SimTech Cluster of Excellence.
- Quantifying Visual Computing Systems**, *Principal Investigator*, project A02 in Transregional Collaborative Research Center 161 (Quantitative Methods for Visual Computing), 2nd funding period.
- 2018 **Visualization of Multi-field Processes in Porous Media**, *Principal Investigator*, project D01 in Collaborative Research Center 1313 (Interface-Driven Multi-Field Processes in Porous Media – Flow, Transport and Deformation).
  - Co-Speaker of task force “Software and data”
- Data-Integrated Simulation Science (EXC 2075)**, *Participating Researcher*, proposal for a DFG Cluster of Excellence, PN6: Machine Learning for Simulation.
- 2017 **Model-based Visual Analysis of Large Spatio-Temporal Data**, *Principal Investigator*, funded project within the SimTech Cluster of Excellence.
- 2015 **Quantifying Visual Computing Systems**, *Co-Author*, project A02 in Transregional Collaborative Research Center 161 (Quantitative Methods for Visual Computing).
- 2011 **MCSimVis: Many Core Simulation and Visualization**, *involvement in proposal*, BMBF Project, with industry partners INTES GmbH and science+computing AG.

## Invited Presentations, Articles, and Posters

- 2018 **Dagstuhl Seminar (In Situ Visualization for Computational Science)**, *Reduced Representation Tradeoffs, Dynamic Prediction and Adjustment*, Talk.

- 2017 **NVIDIA GPU Technology Conference (GTC)**, *Fast Flow-based Distance Quantification and Interpolation for High-Resolution Density Distributions*, Talk.
- 2017 **ChinaVis (China-Germany Visualization Workshop)**, *High Performance Visualization of Volume and Time Series Data*, Talk.
- 2017 **EuroVis**, *Power Efficiency of Volume Raycasting on Mobile Devices*, Poster.
- 2017 **Eurographics**, *Flow-Based Temporal Selection for Interactive Volume Visualization*, Invited Talk of CGF paper.
- 2015 **ISC - Workshop on Software Frameworks for Scalable Scientific Simulations**, *Reduced Representations for In-Situ Visualization*, Talk.
- 2014 **GI BDVC**, *Quantifying Visual Computing Systems*, Talk.
- 2013 **ParCo**, *Interaction and HPC: Multi-Scale / Multi-Physics Applications*, Parallel Interactive Visualization: Strategies and Examples, Talk.
- 2012 **High Performance Visualization: Enabling Extreme-Scale Scientific Insight**, *GPU-Accelerated Visualization*, Book Chapter.
- 2009 **NVIDIA GPU Technology Conference (GTC)**, *Memory Saving Fourier Transform on GPUs*, Talk.
- 2009 **VIS**, *CUDA-Accelerated Continuous 2-D Scatterplots*, Poster.

## Supervised PhD Students (together with Prof. Ertl)

- since 2018 **Moritz Heinemann**, *SFB TRR 75*, "Interactive Visualization of Droplet Dynamics".
- since 2018 **Stefan Scheller**, *SFB 1313*, "Visualization of Multi-field Processes in Porous Media".
- since 2017 **Gleb Tkachev**, *SimTech Cluster of Excellence*, "Model-based Visual Analysis of Large Spatio-Temporal Data".
- since 2016 **Valentin Bruder**, *SFB TRR 161*, "Quantifying Visual Computing Systems".

## Supervised Bachelor and Master Theses

- 2019 **Visual Analysis of Experimental Two-Phase Flow in Porous Media Ensemble Data**, *Cihan Erol*, Master.
- 2018 **Generating field data with GANs for evaluation of visualization performance**, *Elias Fauser*, Master.
- Volume data interpolation using neural networks**, *Hanna Bader*, Bachelor.
- Foveated Volume Rendering**, *Ruben Bauer*, Bachelor.
- Machine Learning-based Analysis of Droplet Behavior in Multiphase Flow Simulations**, *Moritz Heinemann*, Master.
- 2017/18 **Analysis of Spatiotemporal Ensemble Data using Machine Learning**, *Stefan Scheller*, Master.
- Encoding Quality Prediction for Interactive Remote Visualization**, *Mathias Landwehr*, Master.
- 2017 **Investigation of Volume Rendering Performance through Active Learning and Visual Analysis**, *Stephan Roth*, Master.
- Investigation of State-of-the-Art Compression Algorithms for Densely Recorded Light Fields**, *Clemens Sigel*, Bachelor.

- 2016/17 **Investigation and prediction of distributed volume rendering performance**, *Gleb Tkachev*, Master.  
**Progressive Sparse Coding for In Situ Volume Visualisation**, *Gratian Berian*, Master.
- 2015/16 **Performance Quantification of Volume Visualization**, *Valentin Bruder*, Master.  
**Real-time Ray Tracing of Volumetric Data**, *Marcus Richter*, Bachelor.
- 2014/15 **Dynamic Acceleration Structures for the Visualization of Time-Dependent Volume Data on the GPU**, *Hajun Jang*, Diplom.
- 2014 **Adaptive Frameless Raycasting for Interactive Volume Visualization**, *Constantin Weisser*, Bachelor.
- 2012/13 **Extraction of High Quality Isosurfaces from Large Volume Data**, *Thomas Mezger*, Diplom.
- 2010 **Distributed Raytracing on GPU Clusters**, *Jochen Puff*, Diplom.
- 2009/2010 **Algorithm Design and Algorithmic-Level Optimization of Video / Image Algorithm using an Abstract Common Interface for NVIDIA CUDA and Intel Larrabee Platforms**, *Daniel Kauker*, Diplom, in collaboration with Sony Deutschland.  
**Parallel Computation of Volumetric Illumination of Astrophysical Nebulae on GPU Clusters**, *Manuel Moser*, Diplom.

## Lectures, Courses and Seminars

- 2015–20 **Lecture**, *Scientific Visualization (together with Prof. Ertl)*, Master (4 SWS).
- 2019/20 **Advanced Seminar**, *Advanced Rendering*, Master (2 SWS).
- 2019 **Seminar**, *Realistische Echtzeitgrafik*, Bachelor (2 SWS).
- 2018/19 **Advanced Seminar**, *Particle Visualization*, Master (2 SWS).
- 2018 & 19 **Lecture**, *Simulation Technology B (interdisciplinary SimTech lecture)*, Master (4 SWS).
- 2017/18 **Advanced Seminar**, *Multifield Visualization*, Master (2 SWS).  
**SimTech Seminar**, *Multifield Problems*, Master / Ph.D (2 SWS).
- 2016/17 **Advanced Seminar**, *High-Performance Visualization*, Master (2 SWS).
- 2015/16 **Advanced Seminar**, *Virtual Reality*, Master (2 SWS).
- 2015/16 **Lecture**, *Programming for Media Computer Science*, Bachelor (4 SWS).
- 2015 **Advanced Seminar**, *SimTech*, Master / Ph.D (2 SWS).
- 2012/13 **Advanced Seminar**, *Advanced Visualization Techniques*, Master (2 SWS).
- 2012/13 **Advanced Seminar**, *Volume Rendering*, Master (2 SWS).
- 2011 **Seminar**, *Interactive Visualization Techniques*, Master (2 SWS).
- 2010 **Advanced Seminar**, *Volume Rendering*, Master (2 SWS).
- 2009/10 **Lecture (Exercises)**, *Visual Computing*, Master (4 SWS).
- 2009 **Lecture (Exercises)**, *Image Synthesis/Rendering*, Master (4 SWS).
- 2008/09 **Lecture (Exercises)**, *Visual Computing*, Master (4 SWS).
- 2008/09 **Practical Course**, *Graphics and GPU programming lab*, Master (4 SWS).

## Professional Service

### Conference Organization

- 2021 **PacificVis 2021**, Poster Co-Chair.
- from 2020 **EG Symposium on Parallel Graphics and Visualization (EGPGV)**, Steering Committee Member.
- 2020 **EG Symposium on Parallel Graphics and Visualization (EGPGV)**, Symposium Chair.  
**Symposium on Large Data Analysis and Visualization (LDAV)**, Poster Co-Chair.
- 2016–20 **ISC Workshop on In Situ Visualization (WOIV)**, Organizer.
- 2019 **EG Symposium on Parallel Graphics and Visualization (EGPGV)**, Program Co-Chair.
- 2018 **International Conference on Quantification in Visual Computing**, Poster Chair.

### Program Committee

- 2020 **EuroVis**, *Short Papers Track*.  
**VIS**, *SciVIS track*.  
**International Conference on Pattern Recognition (ICPR)**, *Track 1: Artificial Intelligence, Machine Learning for Pattern Analysis*.  
**Visualization Meets AI (VisAI)**, workshop held in conjunction with PacificVis.  
**Workshop on Big Data Visual Exploration and Analytics (BigVis 2020)**.  
**Euromicro Conference on Software Engineering and Advanced Applications (SEAAA)**, *Special Track on AI-Enabled Software Development and Operations*.  
**International Conference on Advanced Communications and Computation (INFOCOMP)**.  
**International Symposium on Visual Computing (ISVC)**.  
**International Symposium on Visual Information Communication and Interaction (VINCI)**.
- 2019 **International Symposium on Visual Information Communication and Interaction (VINCI)**.  
**Conference on Graphics, Patterns, and Images (SIBGRAPI)**.  
**VIS**, *SciVIS track*.  
**Euromicro Conference on Software Engineering and Advanced Applications (SEAAA)**, *Special Track on Software and Big Data Analytics*.  
**International Symposium on Vision, Modeling, and Visualization (VMV)**.  
**In Situ Infrastructures for Enabling Extreme-scale Analysis and Visualization (ISAV)**.  
**EuroVis**, *Short Papers Track*.  
**International Symposium on Visual Computing (ISVC)**.  
**Symposium on Large Data Analysis and Visualization (LDAV)**.  
**International Conference on Advanced Communications and Computation (INFOCOMP)**.
- 2018 **VIS**, *SciVIS track*.  
**Euromicro Conference on Software Engineering and Advanced Applications (SEAAA)**, *Special Track on Software and Big Data Analytics*.  
**International Symposium on Vision, Modeling, and Visualization (VMV)**.

**In Situ Infrastructures for Enabling Extreme-scale Analysis and Visualization (ISAV).**  
*EuroVis, Short Papers Track.*

**International Symposium on Visual Computing (ISVC).**

**Symposium on Large Data Analysis and Visualization (LDAV).**

**Supercomputing (SC), Data Analytics, Visualization & Storage track.**

**Supercomputing Asia.**

**International Supercomputing Conference (ISC).**

**International Conference on Advanced Communications and Computation (INFOCOMP).**

2017 *EuroVis, Short Papers Track.*

**International Symposium on Visual Computing (ISVC).**

**Symposium on Large Data Analysis and Visualization (LDAV).**

**International Supercomputing Conference (ISC).**

**SIGGRAPH ASIA Symposium on Visualization.**

2016 **International Symposium on Visual Computing (ISVC).**

**Symposium on Large Data Analysis and Visualization (LDAV).**

**SIGGRAPH ASIA Symposium on Visualization.**