Umberto Villa, Ph.D.

CONTACT INFORMATION

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My research interests and expertise are in computational engineering and imaging science. My work is uniquely informed by my transdisciplinary training and approaches, combining engineering, mathematical modeling, and scientific computing. My ultimate goal is to exploit the power of computing to accelerate scientific discovery and engineering innovation. My current research focuses on advancing emerging quantitative image modalities to help resolve major challenges in medicine and public health, including early detection of cancers and improved treatment outcomes.

EDUCATION

Emory University, Atlanta, GA (United States)
PhD in Mathematics **2012**

Politecnico di Milano, Milan (Italy) & **Politecnico di Torino**, Turin (Italy)
ASP diploma - Alta Scuola Politecnica **2008**

Politecnico di Milano, Milan (Italy) & **Politecnico di Torino**, Turin (Italy)
Dual Master's degree in Mathematical Engineering, cum laude **2007**

Politecnico di Milano, Milan (Italy)
Bachelor's degree in Mathematical Engineering, cum laude **2005**

EMPLOYMENT

The University of Texas at Austin, Austin, TX
Oden Institute for Computational Engineering and Science

Research Associate Professor **2024 –**
Research Scientist **2022 – 2024**
Research Associate **2015 – 2018**

University of Illinois, Urbana-Champaign, IL
Department of Bioengineering

Adjunct Research Associate Professor **2024 –**
Adjunct Research Assistant Professor **2020 – 2024**

Washington University in St. Louis, St. Louis, MO
Electrical & Systems Engineering

Research Assistant Professor **2018 – 2022**
Imaging Science Ph.D. Program Faculty **2018 – 2022**
Institute of Public Health Faculty Scholar **2020 – 2022**

Lawrence Livermore National Laboratory (LLNL), Livermore, CA
Center for Applied Scientific Computing

Visiting Scientist **2015 – 2021**
Postdoctoral Researcher **2013 – 2015**
Student Internship **Summers 2011 & 2012**

Oak Ridge National Laboratory (ORNL), Oak Ridge, TN
Computer Science and Mathematics Division

Student Internship **Summers 2009 & 2010**

HONORS, FELLOWSHIPS AND AWARDS

1. Best Student Paper Award, 12th Copper Mountain Conference on Iterative Methods, Copper Mountain, Colorado, US **2012**
2. Laney Graduate School Scholarship, Emory University, Atlanta, GA **2008 – 2012**
3. Alta Scuola Politecnica Scholarship, Politecnico of Milano, Milan, Italy, **2005 – 2007**

4. Medal for best graduate recipient, B.S. in Mathematical Engineering, Politecnico of Milano, Milan, Italy **2005**
5. International Mathematical Olympiad (National phase), Cesenatico, Italy **2001**

Honors and awards as part of a team

6. Seno Medical Best Paper Award, Photons Plus Ultrasound: Imaging and Sensing 2022, SPIE Photonics West BIOS, San Francisco, CA, US **2022**

Honors and awards to students and mentees:

7. Luke Lozenski (PhD candidate I advise): Imaging Science Pathway Fellowship, Washington University in St Louis. Full salary support. **2022– 2024**
   This fellowship, funded by an NIH T32 Training Grant, is a highly competitive award that recognize academic excellence of graduate students in the McKelvey School of Engineering and the Medical School at Washington University.
8. Refik Mert Cam (PhD student I co-advise): Elsa and Floyd Dunn award **2024**
   This award honors graduate students with demonstrated research interest in topics including, but not limited to, biomedical ultrasound, bioengineering, and related fields.
9. Fu Li (PhD student I co-advise): Ultrasonic Imaging and Tomography Cum Laude Poster Award, SPIE Conference on Medical Imaging, **2024**
10. Luke Lozenski (PhD candidate I advise): Applied Machine Learning Summer Fellowship, Los Alamos National Laboratory, **2023**

Grants and Contracts

Awarded research grants

1. **U. Villa (PI)**, M Anastasio, S Ermilov, M Pagel (Co-Is). *Advancing three-dimensional preclinical dynamic contrast-enhanced photoacoustic computed tomography via quantitative image reconstruction*, National Institute of Health (NIH), National Institute of Biomedical Imaging and Bioengineering, NIH R01 EB034261
   02/15/24—01/31/28 **$2,352,889**
2. **U. Villa**, M. Pagel (**MPIs**), *Safe, Accurate Assessment of Treatment Response via Dynamic Contrast Enhanced Multispectral Optoacoustic Tomography Imaging of Tumor Perfusion*, The Joint Center for Computational Oncology (JCCO), Oncological Data and Computational Sciences program.
   09/01/23 – 08/31/24 **$50,000** (Direct Costs)
3. M. Anastasio, A. Oraevsky (MPIs); F. Brooks (Co-I), **U. Villa (Co-I & subaward PI)**, *A Computational Framework Enabling Virtual Imaging Trials of 3D Quantitative Optoacoustic Tomography Breast Imaging*, National Institute of Health (NIH), National Institute of Biomedical Imaging and Bioengineering, NIH R01EB031585
   08/01/22 — 04/30/26 awarded to date $1,297,368; expected **$2,318,539**
   Subaward amount $391,984
4. S. Ermilov (PI), M. Anastasio (Co-I), S. Emelianov (Co-I), **U. Villa (Co-I & subaward PI)**. *Integrated photoacoustic and fluorescence imaging system for anatomical, functional, and molecular characterization of murine models*, National Institute of Health (NIH), Novel Tools and Devices for Animal Research Facilities and to Support Care of Animal Models, NIH R44OD023029
   08/15/22—07/31/24 **$1,924,204**
   Subaward amount $96,068
5. M. Anastasio and N. Duric (MPIs); **U. Villa (Co-I & subaward PI)**, *Advanced image reconstruction for accurate and high-resolution breast ultrasound tomography*, National Institute of Health, National Institute of Biomedical Imaging and Bioengineering, NIH R01EB028652
   09/01/19—08/31/24 **$2,179,420**
   Subaward amount $250,761
6. T. Kim (PI); L. Henke, G. Hugo, C. Park, M. Schmidt,**U. Villa**, H. Yi (**Co-Is**), *MRI augmented X-ray imaging-guided adaptive radiotherapy for pancreatic cancer (MAX-guided ART)*, Siteman Investment Program (Pre-R01 Award)
   07/01/21–06/30/23 **$200,000**

7. **U. Villa (PI)**, *ADLA: Automatic differentiation and local assembly of exotic finite element variational forms in MFEM*, LLNL B638337 subcontract
   11/01/19–10/31/20 **$59,999**
8. O. Ghattas (PI) and **U. Villa (Co-PI)**, *Collaborative Research: SI2-SSI: Integrating Data with Complex Predictive Models under Uncertainty: An Extensible Software Framework for Large-Scale Bayesian Inversion*, National Science Foundation, Division of Advanced Cyberinfrastructure, Grant ACI-1550593
   09/01/16–08/31/20 **$350,885**
   A collaborative research project (separate awards) with N. Petra (UC-Merced), Y. Marzouk and M. Parno (MIT) with total funding of $1.35M

In-Kind research grants: Computational resources

9. **U. Villa**, M. Pagel (**MPI**), *Safe, Accurate Assessment of Treatment Response via Dynamic Contrast Enhanced Multispectral Optoacoustic Tomography Imaging of Tumor Perfusion*, The Joint Center for Computational Oncology (JCCO), Oncological Data and Computational Sciences program, 12,500 SUs, 2023–2024
10. M. Anastasio (PI), **U. Villa (Co-PI)**, *Distributed GPU-accelerated image reconstruction methods for breast ultrasound computed tomography*, Illinois Delta research allocation, 16,000 GPU-hours, 2022
11. M. Anastasio (PI), **U. Villa (Co-PI)**, *A computational framework integrating wave physics simulation and machine learning for fast and accurate transcranial photoacoustic tomography reconstruction*, Illinois Blue Waters research allocation, 210,000 node-hours, 2021
12. M. Anastasio (PI); J. Poudel, **U. Villa (Co-PI)**, *Safe and rapid functional brain imaging with transcranial photoacoustic tomography: Accelerating iterative image reconstruction algorithms using GPUs*, Illinois Blue Waters research allocation, 210,000 node-hours (estimated value of awarded resources $130,263), 2020

Awarded educational grants

13. 0. Ghattas, Y. Marzouk, M. Parno, N. Petra, G. Stadler, and **U. Villa**,
    2018 Gene Golub SIAM Summer School entitled *Inverse Problems: Systematic Integration of Data with Models under Uncertainty*, Society for Industrial and Applied Mathematics (SIAM)
    Note: training grant for organizing a 2-week summer school on inverse problems in Breckenridge, CO
    June 16—30, 2018 **$109,200**

In-Kind educational grants: Computational resources

14. **U. Villa (PI)**, Computing resources for the graduate level course *Computational and Variational Inverse Problems*, Explore ACCESS (educational) allocation MTH230002, 400,000 credits, 2023–
15. **U. Villa (PI)**, Computing resources for the graduate level course *Tools and Techniques of Computational Science*, TACC Instructional allocation CSE-380-Tools-and-Te, 2022–
16. **U. Villa (PI)**, Cloud computing resources for the graduate level course on *Computational Methods in Imaging Science*, XSEDE educational allocation TG-SEE190001, 100,000 CPU hours (estimated value of awarded resources $8,445), 2019–2020
17. **U. Villa (PI)** and N. Petra (Co-PI), Cloud computing resources for the *2018 Gene Golub SIAM Summer School* entitled *Inverse Problems: Systematic Integration of Data with Models under Uncertainty*, XSEDE educational allocation TG-DMS180009, 60,000 CPU hours (estimated value of awarded resources $10,014), 2018.

Research Experience

Advancing three-dimensional preclinical dynamic contrast-enhanced photoacoustic computed tomography via quantitative image reconstruction
The broad objective of this collaborative project is to develop, refine, and validate 4D and 5D image reconstruction methods with applications to dynamic contrast enhanced photoacoustic computed

tomography. The proposed approach leverages non-convex optimization techniques and proximal methods to incorporate data-driven and low-rank based image priors.
Funding: NIH, National Institute of Biomedical Imaging and Bioengineering (NIBIB), R01 EB034261.
Role: **PI** **2024 –**

Safe, Accurate Assessment of Treatment Response via Dynamic Contrast Enhanced Multispectral Optoacoustic Tomography Imaging of Tumor Perfusion
The broad objective of this collaborative project with Dr. Pagel (MD Anderson) is develop novel and advanced computational and mathematical models to accurately estimate tumor perfusion rates from DCE MSOT images. The proposed methods will be assessed using retrospective DCE MSOT imaging data from a large cohort of 120 mice undergoing radiotherapy (three tumor models, four doses tested).
Funding: The Joint Center for Computational Oncology (JCCO), Oncological Data and Computational Sciences program
Role: **PI** (MD Anderson PI: Marty Pagel) **2023 –**

Exascale Predictive Simulation of Inductively Coupled Plasma Torches
The primary objective of the center is to develop an advanced integrated predictive computational model for an inductively-coupled plasma (ICP) torch, which can make effective use of emerging exascale computing hardware. Funding: Department of Energy; Advanced Simulation and Computing Predictive Science Academic Alliance Program (PSAAP III)
Role: **Senior Software Architect** **2023 –**

A Computational Framework Enabling Virtual Imaging Trials of 3D Quantitative Optoacoustic Tomography Breast Imaging
This project addresses the challenges of reducing over-diagnosis and over-treatment of breast cancer by developing transformative computational methods (learned and/or model-based) to enable three-dimensional (3D) quantitative optoacoustic tomography (OAT) of the vasculature and oxygen saturation distribution within the human breast.
Funding: NIH, National Institute of Biomedical Imaging and Bioengineering (NIBIB), R01EB031585. M. Anastasio, A. Oraevsky (PI)
Role: **Co-Investigator/Subaward PI** **2022 –**

Integrated photoacoustic and fluorescence imaging system for anatomical, functional, and molecular characterization of murine models
This project aims at developing learning-enhanced image reconstruction to enable quantitative dynamic PACT imaging from a reduced number of tomographic views.
Funding: NIH, Small Business Innovation Research Grants (SBIR) , R44OD023029. S. Ermilov (PI)
Role: **Co-Investigator/Subaward PI** **2022 – 2024**

Advanced image reconstruction for accurate and high-resolution breast ultrasound tomography
The broad objective of this project is to maximize the clinical utility of ultrasound computed tomography (USCT) for whole breast imaging by significantly advancing the state-of-the-art in USCT image reconstruction using model-based and learning methods.
Funding: NIH, National Institute of Biomedical Imaging and Bioengineering (NIBIB), R01EB028652. M. Anastasio, N. Duric (PIs)
Role: **Co-Investigator/Subaward PI** **2018 – 2023**

Integrating Data with Complex Predictive Models under Uncertainty: An Extensible Software Framework for Large-Scale Bayesian Inversion
The goal of this study is to develop, disseminate, and support a robust, scalable, high-performance, open-source software framework incorporating a suite of advanced Bayesian inversion algorithms.
Funding: NSF, Office of Advanced Cyberinfrastructure, ACI-1550593. O. Ghattas (PI)
Role: **Co-PI** **2016 – 2020**

Large-scale Inverse Problems and Uncertainty Quantification for Reservoir Modeling
The focus of this joint ExxonMobil–UTEI project is to develop state-of-the-art inversion and uncertainty quantification methods to reservoir models with complex features including faults.
Funding: Joint ExxonMobil-UT Energy Institute Project, UTA17-000408 (EM10480.14). O. Ghattas (PI), G. Biros, T. Bui-Thanh, C. Dawson (Co-PIs)
Role: Research scientist **2017 – 2019**

Bayesian Optimal Experimental Design for Inverse Scattering
The goal of this study is to develop a rigorous Bayesian framework to design source/receiver configuration to maximize identifiability.
Funding: AFOSR, Computational Mathematics program, FA9550-17-1-0190. O. Ghattas (PI), G.

Biros and Y. Marzouk (Co-PIs)
Role: Research scientist **2017 – 2018**

Inference, Simulation, and Optimization of Complex Systems Under Uncertainty: Theory, Algorithms, and Applications to Turbulent Combustion
This project developed an end-to-end, integrated uncertainty quantification framework enabling us to quantify, manage, and minimize uncertainty in large scale multiscale/multiphysics problems.
Funding: DARPA, EQUiPS program, W911NF-15-2-0121. O. Ghattas (PI), R. Moser, G. Biros, K. Willcox, M. Heinkenschloss, A. Stuart, M. Girolami, A. Philpott (Co-PIs)
Role: Research scientist **2016 – 2017**

Towards Optimal Order Resilient Solvers at Extreme Scale (TOORSES)
This project developed large scale linear solvers and preconditioners exploiting multilevel techniques and hierarchical matrices factorizations.
Funding: DOE Office of Advanced Scientific Computing Research. X.-S. Li (lead PI), P. Vassilevski (LLNL PI)
Role: Postdoctoral researcher **2013 – 2015**

Scalable Multilevel UQ Concepts for Extreme-Scale Multiscale Problems
The objective of this project is to develop multilevel techniques to accelerate forward and inverse uncertainty quantification (UQ) tasks involving complex multiphysics partial differential equations models.
Funding: DOE Office of Advanced Scientific Computing Research. Y. Efendiev (lead PI), P. Vassilevski (LLNL PI)
Role: Postdoctoral researcher **2013 – 2015**

Adaptive Dimension Reduction via Coarsening and Multilevel Solvers
This project investigates highly efficient mathematical tools to construct coarse spaces and respective coarse models that are operator-dependent and to expand the applicability of multigrid methods to very general partial differential equations, such as mixed formulations and saddle point systems.
Funding: DOE Office of Advanced Scientific Computing Research. P. Vassilevski (PI)
Role: Graduate research assistant **2011 – 2012**

Multiphysics Multimodel Domain Decomposition: an Application to Conjugate Heat Transfer
This project investigates a general optimization-based framework for multiphysics multimodel Domain Decomposition with applications to conjugate heat transfer and fluid structure interaction problems.
Funding: ORNL Laboratory Directed Research and Development (LDRD). J. Hill (PI)
Role: Graduate research assistant **2009 – 2010**

Scalable Efficient Methods for Incompressible Fluid-dynamics in Engineering Problems (PhD thesis)
Analysis and implementation of a new time-adaptive algorithm for the solution of the unsteady Navier-Stokes equations.
Development of parallel and scalable block preconditioners for saddle point problems.
Application of these new numerical methods to patient specific blood flow simulations with the aim to numerically investigate pathological or clinical flow conditions (e.g. formation of aneurysms in the carotid artery, design of left ventricle assisting devices).
Advisor: Dr. Alessandro Veneziani **2008 – 2012**

Publications

Publications most closely related to **Scientific Machine Learning** I would like to highlight:

[1] Lozenski, L., Cam, R. M., Pagel, M. D., Anastasio, M. A., **Villa, U.,** "ProxNF: Neural Field Proximal Training for High-Resolution 4D Dynamic Image Reconstruction". In: *Transactions on Computational Imaging* 10 (2024), pp. 1368–1383. DOI: 10.1109/TCI.2024.3458397.

[2] Lozenski, L., Anastasio, M. A., **Villa, U.,** "A Memory-Efficient Self-Supervised Dynamic Image Reconstruction Method Using Neural Fields". In: *IEEE Transactions on Computational Imaging* 8 (2022), pp. 879–892. DOI: 10.1109/TCI.2022.3208511.

[3] Lozenski, L., Wang, H., Li, F., Anastasio, M., Wohlberg, B., Lin, Y., **Villa, U.,** "Learned Full Waveform Inversion Incorporating Task Information for Ultrasound Computed Tomography". In: *IEEE Transactions on Computational Imaging* 10 (2024), pp. 69–82. DOI: 10.1109/TCI.2024.3351529.

[4] Lin, Y., Feng, S., Theiler, J., Chen, Y., **Villa, U.**, Rao, J., Greenhall, J., Pantea, C., Anastasio, M., Wohlberg, B., "Physics and Deep Learning in Computational Wave Imaging". In: submitted to *Proceedings of the IEEE* (2024).

[5] Cam, R. M., **Villa, U.**, Anastasio, M. A., "Learning a Stable Approximation of an Existing but Unknown Inverse Mapping: Application to the Half-Time Circular Radon Transform". In: *Inverse Problems* 40.8 (2024), p. 085002. DOI: 10.1088/1361-6420/ad4f0a.

Other most significant publications I would like to highlight:

[1] **Villa, U.**, Petra, N., Ghattas, O., "hIPPYlib: An Extensible Software Framework for Large-Scale Inverse Problems Governed by PDEs; Part I: Deterministic Inversion and Linearized Bayesian Inference". In: *ACM Trans. Math. Softw.* 47.2 (Apr. 2021). ISSN: 0098-3500. DOI: 10.1145/3428447.

[2] Puel, S., Becker, T. W., **Villa, U.**, Ghattas, O., Liu, D., "Volcanic arc rigidity variations illuminated by coseismic deformation of the 2011 Tohoku-oki M9". In: *Science Advances* 10.23 (2024), eadl4264. DOI: 10.1126/sciadv.adl4264. eprint: https://www.science.org/doi/pdf/10.1126/sciadv.adl4264.

[3] O'Leary-Roseberry, T., **Villa, U.**, Chen, P., Ghattas, O., "Derivative-Informed Projected Neural Networks for High-Dimensional Parametric Maps Governed by PDEs". In: *Computer Methods in Applied Mechanics and Engineering* 388 (2022), p. 114199. ISSN: 0045-7825. DOI: 10.1016/j.cma.2021.114199.

[4] Vassilevski, P. S., **Villa, U.,** "A mixed formulation for the Brinkman problem". In: *SIAM Journal on Numerical Analysis* 52.1 (2014), pp. 258–281. DOI: 10.1137/120884109.

[5] Osborn, S., Vassilevski, P. S., **Villa, U.,** "A Multilevel Hierarchical Sampling Technique for Spatially Correlated Random Fields". In: *SIAM Journal on Scientific Computing* 39.5 (2017), S543–S562. DOI: 10.1137/16M1082688. eprint: 1703.08498.

Complete list of Peer-Reviewed Journal Articles

Scientific journal articles as *first* or *senior* author:

[1] Lozenski, L., Cam, R. M., Pagel, M. D., Anastasio, M. A., **Villa, U.,** "ProxNF: Neural Field Proximal Training for High-Resolution 4D Dynamic Image Reconstruction". In: *Transactions on Computational Imaging* 10 (2024), pp. 1368–1383. DOI: 10.1109/TCI.2024.3458397.

[2] Cam, R. M., Wang, C., Thompson, W., Ermilov, S. A., Anastasio, M. A., **Villa, U.,** "Spatiotemporal Image Reconstruction to Enable High-Frame Rate Dynamic Photoacoustic Tomography with Rotating-Gantry Volumetric Imagers". In: *Journal of Biomedical Optics* 29.S1 (2024), S11516. DOI: 10.1117/1.JBO.29.S1.S11516.

[3] Lozenski, L., Wang, H., Li, F., Anastasio, M., Wohlberg, B., Lin, Y., **Villa, U.,** "Learned Full Waveform Inversion Incorporating Task Information for Ultrasound Computed Tomography". In: *IEEE Transactions on Computational Imaging* 10 (2024), pp. 69–82. DOI: 10.1109/TCI.2024.3351529.

[4] Kalchev, D. Z., Vassilevski, P. S., **Villa, U.,** "Parallel Element-based Algebraic Multigrid for H(curl) and H(div) Problems Using the ParELAG Library". In: *SIAM Journal on Scientific Computing* 45.3 (2023), S371–S400. DOI: 10.1137/21M1433253.

[5] Lozenski, L., Anastasio, M. A., **Villa, U.,** "A Memory-Efficient Self-Supervised Dynamic Image Reconstruction Method Using Neural Fields". In: *IEEE Transactions on Computational Imaging* 8 (2022), pp. 879–892. DOI: 10.1109/TCI.2022.3208511.

[6] **Villa, U.**, Petra, N., Ghattas, O., "hIPPYlib: An Extensible Software Framework for Large-Scale Inverse Problems Governed by PDEs; Part I: Deterministic Inversion and Linearized Bayesian Inference". In: *ACM Trans. Math. Softw.* 47.2 (Apr. 2021). ISSN: 0098-3500. DOI: 10.1145/3428447.

[7] **Villa, U.**, Petra, N., Ghattas, O., "hIPPYlib: an Extensible Software Framework for Large-scale Deterministic and Bayesian Inverse Problems". In: *Journal of Open Source Software* 3.30 (2018), p. 940. DOI: 10.21105/joss.00940.

[8] Christensen, M., Vassilevski, P. S., **Villa, U.,** "Nonlinear Multigrid solvers exploiting AMGe coarse spaces with approximation properties". In: *Journal of Computational and Applied Mathematics* 340 (2018), pp. 691–708. ISSN: 0377-0427. DOI: 10.1016/j.cam.2017.10.029.

[9] Osborn, S., Vassilevski, P. S., **Villa, U.,** "A Multilevel Hierarchical Sampling Technique for Spatially Correlated Random Fields". In: *SIAM Journal on Scientific Computing* 39.5 (2017), S543–S562. DOI: 10.1137/16M1082688. eprint: 1703.08498.

[10] Vassilevski, P. S., **Villa, U.,** "A mixed formulation for the Brinkman problem". In: *SIAM Journal on Numerical Analysis* 52.1 (2014), pp. 258–281. DOI: 10.1137/120884109.

[11] Vassilevski, P. S., **Villa, U.,** "A block-diagonal algebraic multigrid preconditioner for the Brinkman problem". In: *SIAM Journal on Scientific Computing* 35.5 (2013), S3–S17. DOI: 10.1137/120882846.

[12] Veneziani, A., **Villa, U.,** "ALADINS: An ALgebraic splitting time ADaptive solver for the Incompressible Navier–Stokes equations". In: *Journal of Computational Physics* 238 (2013), pp. 359–375. DOI: 10.1016/j.jcp.2012.11.049.

Publications with significant contributions in *all* the research aspects (refinement of the original idea, study design, implementation, writing, mentoring of students/trainees)

[13] Li, K., **Villa, U.**, Li, H., Anastasio, M., "Application of Learned Ideal Observers for Estimating Task-Based Performance Bounds for Computed Imaging Systems". In: *Journal of Medical Imaging* 11.2 (2024), p. 026002. DOI: 10.1117/1.JMI.11.2.026002.

[14] Jeong, G., Li, T., Duric, N., **Villa, U.**, Anastasio, M., "Investigating the Use of Traveltime and Reflection Tomography for Deep Learning-Based Sound-Speed Estimation in Ultrasound Computed Tomography". In: *IEEE Trans on Ultrasonic, Ferroelectrics, and Frequency Control Early Access* (2024). DOI: 10.1109/TUFFC.2024.3459391.

[15] Cam, R. M., **Villa, U.**, Anastasio, M. A., "Learning a Stable Approximation of an Existing but Unknown Inverse Mapping: Application to the Half-Time Circular Radon Transform". In: *Inverse Problems* 40.8 (2024), p. 085002. DOI: 10.1088/1361-6420/ad4f0a.

[16] Kim, K.-T., **Villa, U.**, Parno, M., Marzouk, Y., Ghattas, O., Petra, N., "hIPPYlib-MUQ: A Bayesian Inference Software Framework for Integration of Data with Complex Predictive Models under Uncertainty". In: *ACM Trans. Math. Softw.* 49.2 (2023). DOI: 10.1145/3580278.

[17] Puel, S., Becker, T. W., **Villa, U.**, Ghattas, O., Liu, D., "An adjoint-based optimization method for jointly inverting heterogeneous material properties and fault slip from earthquake surface deformation data". In: *Geophysical Journal International* 236 (2 2023), pp. 778–797. DOI: 10.1093/gji/ggad442.

[18] O'Leary-Roseberry, T., Chen, P., **Villa, U.**, Ghattas, O., "Derivative Informed Neural Operator: An Efficient Framework for High-Dimensional Parametric Derivative Learning". In: *Journal of Computational Physics* (2023), p. 112555. ISSN: 0021-9991. DOI: 10.1016/j.jcp.2023.112555.

[19] Li, F., **Villa, U.**, Duric, N., Anastasio, M. A., "A forward model incorporating elevation-focused transducer properties for 3D full-waveform inversion in ultrasound computed tomography". In: *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control* 70.10 (2023), pp. 1339–1354. DOI: 10.1109/TUFFC.2023.3313549.

[20] Zhou, W., **Villa, U.**, Anastasio, M. A., "Ideal Observer Computation by use of Markov-Chain Monte Carlo with Generative Adversarial Networks". In: *IEEE Transactions on Medical Imaging* 42.12 (2023), pp. 3715–3724. DOI: 10.1109/TMI.2023.3304907.

[21] Park, S., **Villa, U.**, Cam, R. M., Oraevsky, A., Anastasio, M., "Stochastic three-dimensional numerical phantoms to enable computational studies in quantitative optoacoustic tomography of breast cancer". In: *Journal of Biomedical Optics* 28.6 (2023), p. 066002. DOI: 10.1117/1.JBO.28.6.066002.

[22] Liang, B., Tan, J., Lozenski, L., Hormuth II, D. A., Yankeelov, T. E., **Villa, U.**, Faghihi, D., "Bayesian Inference of Tissue Heterogeneity for Individualized Prediction of Glioma Growth". In: *IEEE Transactions on Medical Imaging* 42.10 (2023), pp. 2865–2875. DOI: 10.1109/TMI.2023.3267349.

[23] Nicholson, R., Petra, N., **Villa, U.**, Kaipio, J. P., "On global normal linear approximations for nonlinear Bayesian inverse problems". In: *Inverse Problems* 39 (5 2023), p. 4001.

[24] Lee, J. J., Bui-Thanh, T., **Villa, U.**, Ghattas, O., "Forward and inverse modeling of fault transmissibility in subsurface flows". In: *Computers & Mathematics with Applications* 128 (2022), pp. 354–367.

[25] Puel, S., Khattatov, E., **Villa, U.**, Liu, D., Ghattas, O., Becker, T. W., "A Mixed, Unified Forward/Inverse Framework for Earthquake Problems: Fault Implementation and Coseismic Slip Estimate". In: *Geophysical Journal International* 230 (2 2022), pp. 733–758.

[26] Kuo, J., Granstedt, J., **Villa, U.**, Anastasio, M. A., "Computing a Projection Operator onto the Null Space of a Linear Imaging Operator: Tutorial". In: *Journal of the Optical Society of America A* 39 (3 2022), pp. 470–481. DOI: 10.1364/JOSAA.443443.

[27] Fairbanks, H. R., **Villa, U.**, Vassilevski, P. S., "Multilevel Hierarchical Decomposition of Finite Element White Noise with Application to Multilevel Markov Chain Monte Carlo". In: *SIAM Journal on Scientific Computing* 43.5 (2021), S293–S316. DOI: 10.1137/20M1349606.

[28] Babaniyi, O., Nicholson, R., **Villa, U.**, Petra, N., "Inferring the basal sliding coefficient field for the Stokes ice sheet model under rheological uncertainty". In: *The Cryosphere* 15.4 (2021), pp. 1731–1750. DOI: 10.5194/tc-15-1731-2021.

[29] Li, F., **Villa, U.**, Park, S., Anastasio, M. A., "Three-dimensional stochastic numerical breast phantoms for enabling virtual imaging trials of ultrasound computed tomography". In: *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control* 69.1 (2022), pp. 135–146. DOI: 10.1109/TUFFC.2021.3112544.

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Theses and dissertations

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Other Research Products

Scientific datasets

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Open source scientific software

1. Lead developer of hIPPYlib - **I**nverse **P**roblems **Py**thon **lib**rary (`https://hippylib.github.io`)
2. Lead developer of Elag, ParElag (element agglomeration multigrid solvers and upscaling tools,

http://github.com/LLNL/parelag)

3. Lead developer of ElagMC, ParElagMC (Multilevel Monte Carlo software based on Elag/ParElag, https://github.com/LLNL/parelagmc)
4. Contributor to the finite element library MFEM (http://mfem.org)
5. Developer of the finite element library LifeV (www.lifev.org)

Conference presentations and Seminars

Spotlight presentations (Best student paper award)

1. *A Block-Diagonal Algebraic Multigrid Preconditioner for the Brinkman Problem*, 12th Copper Mountain Meeting on Iterative Methods, March 25-30, 2012, Copper Mountain, Colorado, US

Oral presentations at conferences

2. *Stochastic numerical phantoms to enable optoacoustic tomography virtual imaging studies*, Virtual Imaging Trials in Medicine - International Summit, April 22-24, 2024, Duke University, Durham, NC
3. *Anatomically Realistic Stochastic Numerical Breast Phantoms for Photoacoustic Virtual Imaging Studies and AI-assisted Image Reconstruction*, SIAM Conference on Uncertainty Quantification, Feb 27 - March 1, 2024, Trieste, IT
4. *Low-Rank Matrix Estimation-Based Spatiotemporal Image Reconstruction for 4D Photoacoustic Computed Tomography* , SIAM Conference on Optimization, May 31- June 2, 2023, Seattle, WA, US
5. *Scalable Laplace Approximation for Bayesian Optimal Experimental Design*, 13^{th} International Conference on Monte Carlo Methods, August 16-20, 2021, University of Mannheim, Germany (held virtually)
6. *Curvature Enhanced MCMC Algorithms for Bayesian Inverse Problems Governed by PDEs*, SIAM Conference on Computational Science and Engineering, March 1-5, 2021, Dallas, TX, US, held virtually
7. *Proximal Newton Method for Inverse Problems with Non-smooth Regularization Term*, SIAM Conference on Imaging Science, July 6-9, 2020, Toronto, Canada, held virtually
8. *Bayesian Inference of Fault Properties in Two-phase Porous Media Flow*, $56^t h$ Annual Technical Meeting of Society of Engineering Science, October 13-15, 2019, St. Louis, MO, US
9. *Scalable optimal experimental design for large scale non-linear Bayesian inverse problems*, Applied Inverse Problems, July 8-12, 2019, Grenoble, France
10. *hIPPYlib: An Extensible Software Framework for Large-Scale Bayesian Inverse Problems with Quantified Uncertainties*, FEniCS Conference, June 12-14, 2019, Washington, D.C., US
11. *Scalable Methods for Bayesian Optimal Experimental Design Using Laplace Approximation*, SIAM Conference on Computational Science and Engineering, Feb 25- March 1, 2019, Spokane, WA, US
12. *Maximize the Expected Information Gain in Bayesian Experimental Design Problems: a Fast Optimization Algorithm Based on Laplace Approximation and Randomized Eigensolvers*, SIAM Conference on Uncertainty Quantification, April 16-19, 2018, Garden Grove, CA, US
13. *hIPPYlib: An Extensible Software Framework for Large-Scale Deterministic and Linearized Bayesian Inverse Problems*, Texas Applied Mathematics and Engineering Symposium, Sept. 21–23, 2017, Austin, TX, US
14. *Taylor Approximation for PDE-Constrained Optimal Control Problems Under High-Dimensional Uncertainty: Application to a Turbulence Model*, SIAM Conference on Control and its Applications, July 10-12, 2017, Pittsburgh, PA, US
15. *Derivative-informed MCMC for Bayesian Calibration of Stochastic PDE Models*, SIAM Annual Meeting, July 10-14, 2017, Pittsburgh, PA, US
16. *Hessian-based Sampling Techniques for Bayesian Inverse Problems with Stochastic PDE Forward Model*, Applied Inverse Problems, May 29-Jun 2, 2017, Hangzhou, China
17. *Bayesian Calibration of Inadequate Stochastic PDE Models*, SIAM Conference on Computational Science and Engineering, Feb 27-March 3, 2017, Atlanta, GA, US

18. *Bayesian Inverse Problems Governed by Stochastic PDE Models*, Joint Mathematics Meetings, January 4-7, 2017, Atlanta, GA, US
19. *An Analytical Technique for Forward and Inverse Propagation of Uncertainty*, SIAM Conference on Uncertainty Quantification, April 5-8, 2016, Lausanne, Switzerland
20. *Highly Scalable Hierarchical Sampling Algorithms for Gaussian Random Fields*, SIAM Conference on Computational Science and Engineering, March 14-18, 2015, Salt Lake City, UT, US
21. *AMG Solvers for Upscaled Mixed Finite Element Discretizations*, 13th Copper Mountain Conference on Iterative Methods, Apr 6 - 11, 2014, Copper Mountain, CO, US
22. *Multilevel Monte Carlo Simulations with Algebraically Constructed Coarse Spaces*, SIAM Conference on Uncertainty Quantification, March 31 - Apr 3, 2014, Savannah, GA, US
23. *Robust Numerical Methods for the Brinkman Problem*, 9th International Conference on Large-Scale Scientific Computations, June 3-7, 2013, Sozopol, Bulgaria (with travel support from symposium organizers)
24. *Block AMG Preconditioners For Mixed Finite Element Discretization of Porous Media Flow Problems*, 16th Copper Mountain Conference on Multigrid Methods, March 17-22, 2013, Copper Mountain, CO, US
25. *PALADINS: Scalable Time-adaptive Algebraic Splitting and Preconditioners for the Navier-Stokes Equations*, SIAM Conference on Computational Science and Engineering, Feb 25-March 1, 2013, Boston, MA, US
26. *PALADINS: a Scalable Solver for the Navier-Stokes Equations*, SIAM Conference on Parallel Processing for Scientific Computing, Feb 15-17, 2012, Savannah, GA, US
27. *PALADINS: A Parallel Algebraic Adaptive Navier-Stokes Solver*, SIAM Conference on Computational Science and Engineering, Feb 28-March 4, 2011, Reno, NV, US
28. *ALADINS: an ALgebraic ADaptive Incompressible Navier-Stokes solver*, XVIII International Conference on Computational Methods in Water Resources, June 21-24, 2010, Barcelona, Spain (student volunteer with partial travel support)

Poster presentations at conferences and workshops

29. *Integrating Data with Complex Predictive Models under Uncertainty: An Extensible Software Framework for Large-Scale Bayesian Inversion*, NSF CSSI PI Meeting, 2020, Seattle, Wa, US
30. *Systematic Integration of Data with Models under Uncertainty*, 21st Century Imaging Sciences Pathway Annual Retreat, June 7^{th}, 2019, St. Louis, MO, US
31. *Integrating Data with Complex Predictive Models under Uncertainty: An Extensible Software Framework for Large-Scale Bayesian Inversion*, NSF SI2 PI Meeting, 2017, Arlington, VA, US
32. *Hard problems are fine to coarsen*, Computation Postdoc Poster Symposium, March 24^{th}, 2014, Livermore, CA, US
33. *Upscaling Techniques for the Brinkman Problem*, 2013 DOE Applied Mathematics Program meeting, August 6-8, 2013, Albuquerque, NM, US
34. *Towards Scalable Solvers for the Brinkman Problem*, Lawrence Livermore Student Poster Symposium, August 8^{th}, 2012, Livermore, CA, US
35. *Robust numerical methods for the Brinkman problem*, Lawrence Livermore Student Poster Symposium, August 10^{th}, 2011, Livermore, CA, US
36. *ALgebraic time ADaptive splitting schemes for the Incompressible Navier-Stokes equations*, 2011 Georgia Scientific Computing Symposium, Feb. 12^{th}, 2011, Atlanta, GA, US
37. *Multiphysics Multimodel Domain Decomposition: An Application to Conjugate Heat Transfer*, 2010 Georgia Scientific Computing Symposium, Feb. 20^{th}, 2010, Atlanta, GA, US

Seminar presentations

38. *Towards Digital Twins of Emerging Medical Imaging Modalities: Mathematical Challenges and Opportunities*, University of Houston, Houston, TX, January 19^{th}, 2024, Host *Annalisa Quaini*

39. *Dynamic Imaging of Tumor Vascular Perfusion using 4D Photoacoustic Computed Tomography*, Scientific Computing Seminars, University of Houston, Houston, TX, April 13^{th}, 2023, Host *Tsorng-Whay Pan*
40. *Dynamic Imaging of Tumor Vascular Perfusion using 4D Photoacoustic Computed Tomography*, Babuška Forum, Oden Institute, Austin, TX, March 10^{th}, 2023, Host *Dingcheng Luo*
41. *Advancing ultrasound and photoacoustic tomography via virtual imaging trials*, Center for Computational Oncology, Oden Institute, Austin, TX, December 7^{th}, 2022, Host *T. Yankeelov*
42. *Three-dimensional stochastic numerical breast phantoms for enabling virtual imaging trials of ultrasound and photoacoustic computed tomography*, Department of Mechanical and Aerospace Engineering, University at Buffalo, Buffalo, NY, November 4^{th}, 2021. Host *D. Faghihi*
43. *Quantitative Photoacoustic Tomography: Inversion Algorithms & Challenges*, Georgia Tech, Atlanta, GA, June 25^{th}-26^{th}, 2019, *1st Annual Photoacoustic & Florescence Tomography Workshop*
44. *Learning from data through the lens of mathematical models: Bayesian Inverse Problems and Uncertainty Quantification*, Department of Mathematics, Emory University, Atlanta, GA, June 24^{th}, 2019. Host *A. Veneziani*
45. *Learning from data through the lens of mathematical models: A gentle introduction to Bayesian Inverse Problems*, Mathematics Department, Washington University, St. Louis, MO, January 28^{th}, 2019. Host *J. McCarthy*
46. *Large Scale Inverse Problems and Uncertainty Quantification: Computational Tools and Imaging Applications*, Electrical & Systems Engineering, Washington University, St. Louis, MO, January 24^{th}, 2019. Host *J. O'Sullivan*
47. *Numerical Upscaling and Multilevel Monte Carlo*, Stanford University, Palo Alto, CA, November 12^{th}, 2014, *Algorithms and Architectures Initiative Annual Meeting*.
48. *Multilevel Monte Carlo Simulations with Algebraically Constructed Coarse Spaces*, Emory University, Atlanta, GA, March 28^{th}, 2014. Host *A. Veneziani*
49. *Towards Scalable Solvers for the Brinkman Problem*, Stanford University, Palo Alto, CA, March 4^{th}, 2014. Host *H. Techelepi*
50. *Numerical Upscaling and Algebraic Multigrid for Mixed Finite Element discretizations*, Lawrence Berkeley National Laboratory, Berkeley, CA, February 11^{th}, 2014. Host *X. S. Li*
51. *Numerical Upscaling and Algebraic Multigrid for Mixed Finite Element discretizations*, Tuft University, Boston, MA, December 6^{th}, 2013. Host *J. Adler*
52. *An Optimal Control Approach for Multiphysics Multimodel Domain Decomposition*, Stanford University, Palo Alto, CA, November 7^{th}, 2013. Host *M. Saunders*
53. *Towards Scalable Solvers for the Brinkman Problem*, Kennesaw State University, Kennesaw, GA, October 5^{th}, 2013. Host *Y. Babenko*

Schools & workshops by invitation only

1. *Computational Uncertainty Quantification: Mathematical Foundations, Methodology & Data*, May 4-8, 2020, Erwin Schroedinger Institute for Mathematics and Physics (ESI), University of Vienna, Vienna, Austria (virtual)
2. *IdeaLab 2015: Inverse Problems and Uncertainty Quantification*, July 6-10, 2015, Institute for Computational and Experimental Research in Mathematics (ICERM), Brown University, Providence, Rhode Island, Us (with travel support from organizers)
3. *Algebraic Multigrid Summit*, October 15-18, 2014, Boulder, Colorado, US
4. *Algebraic Multigrid Summit*, September 3-8, 2013, Lake City, Colorado, US
5. *Finite Element Exterior Calculus Summer School*, June 11-15, 2012, Institute for Computational and Experimental Research in Mathematics (ICERM), Brown University, Providence, Rhode Island, US (with travel support from organizers)
6. *Adaptive Finite Elements and Domain Decomposition Methods* Workshop, June 17-19, 2010, Milan State University, Milan, Italy

Teaching Experience

University of Texas, Austin, TX

Instructor of Area B courses for the Ph.D. program in Computational Science, Engineering, and Mathematics

Tools & Techniques of Computational Science	**Fall 2024**
Tools & Techniques of Computational Science	**Fall 2023**
Tools & Techniques of Computational Science	**Fall 2022**

Instructor of summer schools/short courses

Gene Golub SIAM Summer School on Inverse Problems	**June 17-30, 2018**

Taught jointly with O. Ghattas, Y. Marzouk, M. Parno, N. Petra, G. Stadler

Lab-instructor for graduate courses

Computational & Variational Inverse Problems (Dr. Ghattas)	**Spring 2024**
Computational & Variational Inverse Problems (Dr. Ghattas)	**Spring 2023**
Computational & Variational Inverse Problems (Dr. Ghattas)	**Fall 2017**

Guest lecturer for graduate level courses

Finite Element Method in Geophysics (Dr. Ghattas): 3 lectures	**Fall 2016**
Computational & Variational Inverse Problems (Dr. Ghattas): 4 lectures	**Fall 2015**
Comput. & Variational Inverse Problems (Dr. Petra, UC Merced): 1 lecture	**Fall 2015**

Washington University, St. Louis, Mo

Instructor of core curriculum courses for the Ph.D. program in Imaging Science

Computational Methods in Imaging Science	**Spring 2020**
Computational Methods in Imaging Science*	**Spring 2019**

* *I developed this course.*

Guest lecturer for undergraduate level courses

Optimization (Dr. Kamilov): 2 lectures	**Spring 2020**
Optimization (Dr. Kamilov): 1 lecture	**Spring 2019**

Emory University, Atlanta, GA

Instructor for undergraduate courses in Calculus I and II

Calculus II (Teaching mentor: Dr. Gould)	**Spring 2012**
Calculus I (Teaching mentor: Dr. Garibaldi)	**Fall 2011**
Calculus II (Teaching mentor: Dr. Batterson)	**Spring 2011**

Teaching Assistant for undergraduate courses in Life Science Calculus and Linear Algebra

Linear Algebra (Lab instructor for Dr. Venapally)	**Fall 2012**
Life Science Calculus I (Lab instructor for Dr. Duffus)	**Fall 2010**
Life Science Calculus II (Lab instructor for Dr. Duffus)	**Spring 2010**
Life Science Calculus I (Lab instructor for Dr. Duffus)	**Fall 2009**
Life Science Calculus II (Grader for Dr. Duffus)	**Spring 2009**
Life Science Calculus I (Grader for Dr. Duffus)	**Fall 2008**
Life Science Calculus II (Grader for Dr. Duffus)	**Spring 2008**

Mentoring Experience

Ph.D. students (main advisor):

1. Evan Scope Craft (CSEM, UT Austin, 2023 –): Optimal experimental design with data-driven priors
2. Luke Lozenski (Electrical & Systems Engineering, WUSTL, 2020 –): Integration of model-based and learned image reconstruction algorithms for quantitative dynamic multispectral photoacoustic imaging of small animal models

Ph.D. students (co-advisor):

3. Kevin Huang (advised by Dr. Anastasio, Bioengineering, UIUC, 2022 –): *Advancing photoacoustic tomography neuroimaging through model-based image reconstruction and learning*
4. Refik Cam (advised by Dr. Anastasio, Electrical & Computer Engineering, 2020 –): *Advanced Image Reconstruction in Photoacoustic Computed Tomography*

5. Fu Li (advised by Dr. Anastasio, Bioengineering, UIUC, 2018 –): *Advanced image reconstruction algorithm for 3D accurate and high-resolution breast ultrasound tomography*

Ph.D. students (dissertation committee member, mentor, or research supervisor):

6. Graham Pash (**dissertation committee member**, Computational Science, Engineering, and Mathematics, UT Austin, advisor: Dr. Willcox; 2023 –): *Towards Predictive digital Twins with Applications in Precision Oncology*
7. Siva Saket Sripada (**dissertation committee member**, Biomedical Engineering, UT Austin, advisor: Dr. Porter; 2023 –):
8. Ziheng Zhang (**research mentor**, Computational Science, Engineering, and Mathematics, UT Austin, advisor Dr. Ghattas; 2022 –): Derivative-informed neural surrogates with applications to geophysical problems
9. Gangwon Jeong (**dissertation committee member**, Bioengineering, UIUC, advisor: Dr. Anastasio; 2020 –): *Joint image reconstructions methods for solving acoustic inverse problems in ultrasound and photoacoustic computed tomography*
10. Panpan Chen (**research mentor**, advised by Dr. Anastasio, UIUC, 2022 –): Benchmarking of deep learning methods for photoacoustic computed tomography
11. Kaiyi Yang (**research mentor**, advised by Dr. Anastasio, UIUC, 2022 –): Compensation of spatial impulse response in photoacoustic computed tomography.
12. Tao Ge (**rotation supervisor**, Electrical & Systems Engineering, WUSTL, Spring 2019): *Proximal Newton Methods for Inverse Problems with Non-Smooth Regularization Term*
13. C. S. Lee (**Summer Internship co-supervisor** with Dr. Vassilevski, LLNL, 2014): Spectral upscaling method for mixed formulation of Darcy equation
14. M. Christensen (**Summer Internship co-supervisor** with Dr. Vassilevski, LLNL, 2013 & 2014): Mixed finite element methods and numerical upscaling with application to subsurface flow and petroleum engineering
15. S. Ladenheim (**Summer Internship co-supervisor** with Dr. Vassilevski, LLNL, 2013): Generation of Gaussian random field by solving stochastic PDEs
16. D. Emerson (**Summer Internship co-supervisor** with Dr. Vassilevski, LLNL, 2013): Nonlinear multilevel methods

Ph.D. students (informal mentoring, joint publications):

17. Simone Puel (advised by Dr. Beker, Jackson School of Geosciences, 2023): *A mixed forward/inverse modeling framework for earthquake deformation problems*
18. Tom O'Leary-Roseberry (advised by Dr. Ghattas, Oden Institute, UT Austin, 2020): *Efficient and dimension independent methods for neural network surrogate construction and training*
19. Amal Alghamdi (advised by Dr. Ghattas, Oden Institute, UT Austin, 2020): *Bayesian inverse problems for quasi-static poroelasticity with application to ground water aquifer characterization from geodetic data*

M.S. students:

20. Jenil Shah (**Graduate research assistant**, Oden Institute, 2024): Dynamic contrast-enhanced multispectral computed tomograhy
21. Venugopal Ranganathan (**MS thesis co-supervisor** with Dr. Ghattas, Oden Institute, UT Austin, 2024): *hIPPYlibx: Solving inverse problems in hIPPYlib and FEniCSx*
22. Karan Prakash Hiranandani (**MS report co-supervisor** with Dr. Ghattas, Oden Institute, UT Austin, 2023): *hIPPYfire: Solving inverse problems in hIPPYlib and Firedrake*
23. Joseph Kuo (advised by Dr. Anastasio, Electrical & Computer Engineering, 2022): *Advancing Photoacoustic Neuroimaging Through Deep Learning*
24. Ricardo Qiu (**advisor**, Computer Science Engineering, WUSTL, 2021): *Data-driven approaches to solve inverse problems*
25. Argho Dattas (*Research fellowship mentor*, Electrical & Systems Engineering, WUSTL, Spring 2020): *Learning adversarial regularizers for the solution of inverse problems*
26. Jieqiong Xiao (*Research fellowship mentor*, Computer Science Engineering, WUSTL, Spring 2020): *ADLA: Automatic differentiation and local assembly of exotic finite element variational forms in MFEM*
27. Di Liu (advised by Dr. Ghattas, Oden Institute, UT Austin, 2017): *hIPPYLearn: An inexact Stochastic Newton-CG method for training neural networks*

28. Ge Gao (advised by Dr. Ghattas, Oden Institute, UT Austin, 2017): *hIPPYLearn: An inexact Newton-CG method for training neural networks with analysis of the Hessian*

Undergraduate students' mentored research:

29. Thomas Wynn (**Undergraduate research assistant**, UT Austin, 2023–2024): *Photoacoustic computed tomography imaging models*
30. Luke Lozenski (**Independent Study Supervisor**, Electrical & Systems Engineering, WUSTL, Summer 2019): *Learning forward modeling error in Photoacoustic tomography reconstruction*
31. Argho Datta (**Independent Study Supervisor**, Biomedical Engineering, WUSTL, Spring 2019): *Proximal Newton Methods for Medical Imaging*
32. Bassel Saleh (advised by Dr. Ghattas):
    Turing Scholars Honors thesis, UT Austin, 2018: *Scientific Machine Learning: A Neural Network-Based Estimator for Forward Uncertainty Quantification*
    Moncrief Undergraduate Summer Internship, UT Austin, 2016: *Neural Networks as Surrogate Models for Forward and Inverse Problems*

Service to scientific community

Editorial work and peer review

Associate editor for IEEE Open Journal of Signal Processing (EiC: Brendt Wohlberg) since 2023.

Editorial board member of *Numerical Linear Algebra with Applications* (EiC: Panayot Vassilevski) since 2018.

Reviewer for the following journals: *SIAM Journal for Uncertainty Quantification*, *SIAM Journal on Scientific Computing* , *SIAM Journal on Imaging Sciences* (SIAM); *Transactions on Medical Imaging*, *Transactions on Computational Imaging*, *IEEE Photonics Journal* (IEEE); *Journal of Biomedical Optics* (SPIE); *Numerical Linear Algebra with Applications*, *International Journal for Numerical Methods in Engineering* (Wiley); *Computational Geosciences*, *Journal of Scientific Computing*, *Numerical Algorithms*, *Advances in Computational Mathematics*, *Numerische Mathematik* (Springer); *Photoacoustics*, *Journal of Mathematical Analysis and Applications*, *SoftwareX* (Elsevier); *Optics Letters* (Optica); *Ultrasonic Imaging* (SAGE); *Journal of Numerical Mathematics* (De Gruyter); *The Journal of Machine Learning for Biomedical Imaging*; *Communications Engineering*, *Scientific Reports* (Nature)

Grant reviews

Served in 1 NSF grant review panel (Office of Advanced Cyberinfrastructure)
Served as reviewer for the Swiss National Science Foundation (1 proposal)

Education and training

Organize and teach the *2018 Gene Golub SIAM Summer School* on *Inverse Problems: Systematic Integration of Data with Models under Uncertainty*, in collaboration with O. Ghattas, Y. Marzouk, M. Parno, N. Petra, and G. Stadler

Minisymposia/conference-session organization

1. N. Petra, U. Villa, *Recent Advances on PDE-constrained optimization packages and libraries*, International Conference on Continuous Optimization, July 21-24, 2024, Los Angeles
2. S. Henneking, N. Petra, U. Villa, O. Ghattas, *Computational tools for large-scale inverse problems and UQ*, SIAM Conference on Uncertainty Quantification, Feb 27 – Mar 1, 2024, Trieste, Italy
3. D. Faghihi, K. Maupin, A. Tabarraei, U. Villa, *Data-Enabled Predictive Modeling, Machine Learning, and Uncertainty Quantification in Computational Mechanics*, ASME's International Mechanical Engineering Congress & Exposition, Nov 1-4, 2021, *virtual*
4. D. Faghihi, K. Maupin, A. Tabarraei, U. Villa, *Data-Enabled Predictive Modeling, Machine Learning, and Uncertainty Quantification in Computational Mechanics*, ASME's International Mechanical Engineering Congress & Exposition, Nov 15-19, 2020, *virtual*
5. U. Villa, O. Ghattas, *Optimal Experimental Design for Bayesian Inverse Problems*, SIAM Conference on Computational Science and Engineering, Feb 25-March 1, 2019, Spokane, WA, US
6. U. Villa, T. Oliver, N. Petra, O. Ghattas, R. Moser, *Characterizing model inadequacy in Bayesian inference*, SIAM Conference on Uncertainty Quantification, April 16-19, 2018, Garden

Grove, CA, US

7. T. Bui-Thanh, O. Ghattas, V. Rao, U. Villa, *Efficient Algorithms for Bayesian Inverse Problems Governed by PDE Forward Problems*, SIAM Conference on Computational Science and Engineering, Feb 27-March 3, 2017, Atlanta, GA, US

Departmental & Institutional service

UT Austin, Austin, TX

- Ph.D. thesis committee member: Siva Saket Sripada (BME, *current*), Graham Pash (CSEM, *current*)[1]
- Supervise undergraduate and master research
- Participate in recruiting events & activities of the Oden Institute
- Meet & interview candidates for postdoctoral positions

Washington University, St. Louis, MO[2]

- Member of the Ph.D. in Imaging Science *curriculum committee* (2020-2021)
- Ph.D. *dissertation committee member*: Tingting Wu (IS, 2023), Austen Curcuru (BME, 2023), Shuying Li (BME, 2023), Uri Goldsztejn (BME, 2022), Eghbal Amidi(BME, 2021), Jingwei Lu (ESE, 2019)
- M.S. *thesis committee member*: Shangguan Wentao (ESE, 2021), Weiran Wang (ESE, 2019), Shiqi Xu (ESE, 2019)
- Ph.D. *qualifying exam committee member*: Senyue Hao (ESE, 2022), Tingting Wu (IS, 2020), Zhi Wang (IS, 2020), Soumyendu Ghosh (ESE, 2019), Jiaming Liu (ESE, 2019)
- Supervise undergraduate and master research
- Participate in *recruiting activities* for prospective undergraduate and master students

Professional affiliations

SIAM member since 2009.
IEEE member since 2019.

[1] BME=Biomedical Engineering, CSEM=Computational Sciences, Engineering, & Mathematics
[2] BME=Biomedical Engineering, IS=Imaging Science Ph.D. ESE=Electrical & Systems Engineering