Mahindra Singh Rautela

━━━━━━ Research Experience

07/23–Present
(∼ 2.5Y)

Postdoctoral Research Associate – Los Alamos National Laboratory, USA.

1. Project-1: Physics Foundational models (Funded by LDRD-DI)
   - Large-scale vision transformers to learn from diverse heterogeneous PDE datasets.
   - Applications: ICF, particle accelerators, materials, multi-physics.
2. Project-2: Foundation model for Scientific User Facilities Operational Data (Funded by CFLC/programmatic)
   - Masked transformer for imputation and anomaly detection.
3. Project-3: Generative AI for virtual diagnostics in particle accelerators (Funded by LDRD-DR)
   - Prediction of spatiotemporal dynamics of charged particle beams.
   - Uncertainty analysis in spatiotemporal dynamics.
   - Estimation of optimal accelerator settings using latent Bayesian optimization.

01/22–07/23
(∼ 1.5Y)

Graduate Research Assistant (Visiting) – Purdue University, USA.

1. Project: Adaptive leakage estimation in deep space habitats (Funded by NASA-STI)
   - Developed an adaptive optimization scheme called EWARS for leakage estimation.
   - Setup experimental setup with required instrumentations, hooked up to speedgoat and simulink environment.
   - The online leakage estimator uses experimental pressure measurements from the setup in real time.

01/19–06/23
(∼ 4.5Y)

Graduate Research Assistant – Indian Institute of Science, Bangalore.

1. Project-1: Supervised, Unsupervised and Generative ML for guided-wave based damage identification in composite structures
   - Inverse neural surrogate model for detection, localization and severity estimation.
   - Domain Knowledge-assisted ML for damage detection and localization.
   - AE and VAE as anomaly detector for unsupervised damage detection.
2. Project-2: ML-assisted composite material property identification and design
   - Supervised ML based composite material property estimation.
   - VAEs based generators for the design of composite materials.

08/18–12/18
(∼ 0.5Y)

Project Engineer – Indian Institute of Technology, Kanpur.

Project Title: Pipe Health Monitoring Robot (PHMR) to monitor the saefty of gas pipelines.

━━━━━━ Educational Background

2022–2023 **Visiting PhD Student – Purdue University**, *Mechanical Engineering*.
Advisor: Prof. Shirley Dyke

2019–2023 **PhD Student – Indian Institute of Science**, *Faculty of Engineering*, CGPA: 9/10.
Advisor: Prof. S. Gopalakrishnan

2016–2018 **Masters – Indian Institute of Space Science and Technology**, *Structures & Design*, CGPA = 8.91/10.
Advisor: Dr. Bijudas CR

2011–2015 Bachelors (Hons.) – AKTU (formerly UPTU), *Mechanical Engineering (Hons.)*, CGPA = 8.65/10 (81.24%).

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▬▬▬ Publications

Summary Journal articles - 10, Conference articles - 14, Preprints - 2.
Total #Citations (Google scholar) - 720.
H-index (Google scholar) - 13.

Preprints

[1] M. Rautela et al. (2025), *MORPH: PDE Foundation Models with Arbitrary Data Modality*, arXiv:2509.21670.

[2] M. Rautela et al. (2024), *CBOL-Tuner: Classifier-pruned Bayesian optimization to explore temporally structured latent spaces for particle accelerator tuning*, arxiv:2412.01748.

Journal articles

[1] M. Rautela et al. (2024), *Time-inversion of spatiotemporal beam dynamics using uncertainty-aware latent evolution reversal*, Physical Review E, DOI: 10.1103/PhysRevE.111.025307.

[2] M. Rautela et al. (2024), *A conditional latent autoregressive recurrent model for generation and forecasting of beam dynamics in particle accelerators*, Scientific Reports, DOI: 10.1038/s41598-024-68944-0.

[3] E. Monaco, M. Rautela et al. (2024), *Machine learning algorithms for delaminations detection on composites panels by wave propagation signals analysis: Review, experiences and results*, DOI: 10.1016/j.paerosci.2024.100994.

[4] M. Rautela et al. (2023), *Real-time rapid leakage estimation for deep space habitats using exponentially-weighted adaptively-refined search*, Acta Astronautica, DOI: 10.1016/j.actaastro.2022.12.003.

[5] M. Rautela et al. (2022), *Toward deep generation of guided wave representations for composite materials*, IEEE Transactions on Artificial Intelligence, DOI: 0.1109/TAI.2022.3229653.

[6] M. Rautela et al. (2022), *Inverse characterization of composites using guided waves and convolutional neural networks with dual-branch feature fusion*, Mechanics of Advanced Materials and Structures, DOI: 10.1080/15376494.2021.1982090.

[7] M. Rautela et. al. (2022), *Delamination prediction in composite panels using unsupervised-feature learning methods with wavelet-enhanced guided wave representations*, Composite Structures, DOI: 10.1016/j.compstruct.2022.115579.

[8] M. Rautela et al. (2021), *Combined two-level damage identification strategy using ultrasonic guided waves and physical knowledge assisted machine learning*, Ultrasonics, DOI: 10.1016/j.ultras.2021.106451.

[9] M. Rautela and S. Gopalakrishnan (2021), *Ultrasonic guided wave based structural damage detection and localization using model assisted convolutional and recurrent neural networks*, Expert Systems with Applications, DOI: 10.1016/j.eswa.2020.114189.

[10] M. Rautela and Bijudas, C.R., (2019), *Combined two-level damage identification strategy using ultrasonic guided waves and physical knowledge assisted machine learning*, International Journal of Adhesion and Adhesives, DOI: 10.1016/j.ijadhadh.2019.05.002.

Conference articles

[1] M. Rautela et al. (2026), *Out-of-distribution transfer of PDE foundation models to material dynamics under extreme loading*, ICLR AI&PDE Workshop, openreview.net/forum?id=yRC7DqRYsg.

[2] M. Rautela et al. (2026), *PDE foundation model-accelerated inverse estimation of system parameters in inertial confinement fusion*, IPDPS Workshops, arxiv.org/pdf/2603.04606.

[3] M. Rautela et al. (2025), *Advancing accelerator virtual beam diagnostics through latent evolution modeling: an integrated solution to forward, inverse, tuning, and UQ problems*, Proceedings of the NAPAC'25, DOI: 10.18429/JACoW-NAPAC2025-MOP002.

[4] M. Rautela et al. (2024), *Latent evolution model for time-inversion of spatiotemporal beam dynamics*, Proceedings of the LINAC'24, DOI:10.18429/JACoW-LINC2024-MOPB090.

[5] M. Rautela et al. (2024), *Towards latent space evolution of spatiotemporal dynamics of six-dimensional phase space of charged particle beams*, Proceedings of the IPAC'24, DOI:10.18429/JACoW-IPAC2024-MOPS75.

[6] M. Rautela et al. (2024), *Accelerator system parameter estimation using variational autoencoded latent regression*, Proceedings of the IPAC'24, DOI: 10.18429/JACoW-IPAC2024-MOPS74.

[7] M. Rautela et al. (2024), *Bayesian optimized physics-informed neural network for estimating wave propagation velocities*, IEEE conference on AI 2024 (Accepted/In Press), arXiv: 2312.14064.

[8] M. Rautela et al. (2022), *Deep generative models for unsupervised delamination detection using guided waves*, In Proceedings of 8th World Conference on Structural Control and Monitoring (Accepted/In Press), arXiv: 2308.05350.

[9] K. Gopalakrishnan, M. Rautela, and Y. Deng, (2020), *Deep learning based identification ...*, In EWSHM Special Collection of 2020 Papers-Volume 2, pp. 77-90, Springer International Publishing., DOI: 10.1007/978-3-030-64908-1_8.

[10] M. Rautela et al. (2021), *Delamination detection in aerospace composite panels using convolutional autoencoders*, SPIE Smart Structures + NDE, DOI: 10.1117/12.2582993.

[11] M. Rautela et al. (2021), *Temperature compensation for guided waves using convolutional denoising autoencoders*, SPIE Smart Structures + NDE, DOI: 10.1117/12.2582986.

[12] M. Rautela et al. (2020), *Ultrasonic guided waves based identification of elastic properties using 1d-convolutional neural networks*, In 2020 IEEE International Conference on Prognostics and Health Management (ICPHM), DOI: 10.1109/ICPHM49022.2020.9187057.

[13] M. Rautela et al. (2021), *Simulation of guided waves for structural health monitoring using physics-informed neural networks*, IWSHM, DOI: 10.12783/shm2021/36297.

[14] M. Rautela et al. (2019), *Deep Learning frameworks for wave propagation-based damage detection in 1D-waveguides*, NDT in Aerospace Conference, ndt.net/?id=25046.

Invited Talks

27 July 25 Topic: Spatialtemporal learning of magnetohydrodynamics using latent-space cross-attention and autoregressive conditional transformers, *6th International Conference on Data-Driven Plasma Science (ICDDPS–6)"*, Santa Fe, NM, US, Link.

22 July 24 Topic: Conditional latent autoregressive recurrent model for learning spatiotemporal dynamics of charged particles in accelerators, *In Special Session on "Machine Learning for Particle Accelerators"*, CAARI-SNEAP 2024, Fort Worth, Texas, US, Link.

29 May 24 Topic: Learning spatiotemporal dynamics of charged particles in accelerator, *In Workshop on "Applied and Physics Informed Machine Learning for Complex Dynamic Systems", Santa Fe, New Mexico, US*, Link.

01 Dec. 23 Topic: Deep generative modeling approach for composite materials: An accelerated solution of prediction, discovery and design problems, *In Workshop-6 on "Generative Artificial Intelligence: From Algorithm to Scientific Discovery*, Distributed AI (DAI) conference 2023, NTU Singapore, Link.

Competitive honors or awards

2024 Prof. Chintakindi V Joga Rao Medal - Best PhD Thesis Award, *Indian Institute of Science, Bangalore*.

2022 Recipient of Overseas Visiting Doctoral Fellowship (OVDF) from SERB-DST, Government of India, *Merit based competitive fellowship to attend visiting doctoral program at Purdue University*, (Nation wide, 25/500 applicants).

2016-2021	Recipient of Masters and Doctoral fellowship from Ministry of Education, Government of India, *Based of Graduate Aptitude Test in Engineering (GATE) qualifications*, (Nation wide, 15% Acceptance rate).
2018	Second best poster presentation award for conference paper "Electromechanical impedance-based SHM and artificial neural networks for disbond type and severity", *Liquid Propulsion System Center (ISRO) & Aeronautical Society of India*, (3/100 posters).
2015	Gold and Silver Medal for Excellance in Academics, *Undergrad degree*, (University level 1/500 students).

Relevant extracurricular activities

Reviewer for scientific journals (2022 - Present)

| Total = 25 (Publons) | Structural Health Monitoring (16), Smart Materials and Structures (2), Mechanical Systems and Signal Processing (1), ASME-NDE (1), INAE Letters (1), Measurement Science and Technology (2), Scientific Reports (1), IEEE Transactions of Plasma Science (1). |

Reviewer for conferences

| Total = 12 | ICML 2026 (6), ICLR 2026 Workshops (6). |

Session Chair

| March 2025 | Session Chair: PINNs and ML - II, *APS Joint March Meeting and April Meeting: Global Physics Summit 2025*, Anaheim, CA. |

Declaration

I hereby declare that the above mentioned information is correct up to my knowledge and I bear the responsibility for the correctness of the above mentioned particular.

Date: March. 16, 2026

Place: Los Alamos, New Mexico, USA

Mahindra Singh Rautela