IVAN MOROZOV | Curriculum Vitae

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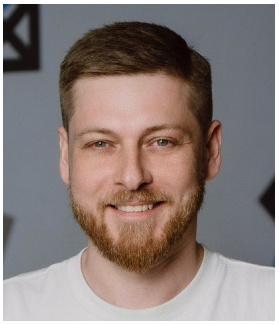
Summary

Accelerator physicist at Budker INP and SKIF. My main research interests are nonlinear dynamics, nonlinear integrable systems, symplectic integrators, chaos detection methods, global optimization, dynamic aperture optimization, online optimization, measurements and correction of accelerator optics, applications of ML methods in accelerators, anomaly detection, surrogate models, ML based correction, differentiable modeling.



Education

Jul. 2010 BS in Physics, **Novosibirsk State Technical University**, Novosibirsk, Russia
Thesis: "Slow beam extraction from synchrotron" | Advisor: Dr. Alexey Petrenko
GPA: 4.28/5.00

Jul. 2013 MS in Physics, **Novosibirsk State Technical University**, Novosibirsk, Russia
Thesis: "Modeling of nonlinear accelerator elements" | Advisor: Dr. Alexey Petrenko
GPA: 5.00/5.00

Additional education

2011 Beam Physics with Intense Space Charge, USPAS, Stony Brook University, USA
2012 Accelerator Physics, USPAS, University of Texas at Austin, USA
2012 Accelerator Physics, IASCL, Raja Ramanna Center for Advanced Technology, India
2018 Numerical Methods for Analysis, Design and Modelling, CAS, Greece
2021 Optimization and Machine Learning for Accelerators, USPAS, (online)
2022 Beam Measurements and Diagnostics on an Electron Storage Ring, USPAS, (online)

Work experience

Sep. 2008 – Jul. 2017 Research assistant at Budker INP, Russia

- Conducted beam slow extraction simulations for Proton Beam Therapy synchrotron.
- Designed and implemented tools for modeling nonstandard nonlinear accelerator elements, including hollow electron lens collimator and polar integrable lenses.
- Participated in integrable ring modeling based on lens integrable in polar coordinates.
- Developed software for analytical computations of normal forms and control term (Hamiltonian control theory).
- Developed tools for application of the Magnus expansion to factorization of accelerator elements into product of Lie exponents.
- Investigated beam-beam compensation by the introduction of another IP.

Jul. 2010 – Aug. 2010 Summer Intern (PARTI) at Fermilab, USA

- Contributed to the development and analysis of high-pressure RF cavities for muon accelerator applications.
- Investigated the impact of alignment imperfections on the performance of high-pressure RF cavities.

Feb. 2011 – Feb. 2012 Guest Scientist at Fermilab, USA

- Developed models of hollow electron lens collimator that accounted for hollow beam imperfections: varying radial beam profile and azimuthal harmonics.
- Conducted collimation simulations for the Tevatron using LifeTrack software.

Jun. 2017 – Jun. 2021 Junior researcher at Budker INP, Russia

- Participated in the NICA collider dynamic aperture studies: impact of final focus quadrupole fringe fields
- Developed software for beam dynamics simulations: dynamic Fortran code generation in Wolfram Mathematica with explicit dynamics of derivatives.
- Developed software for chaos detection: decomposition and analysis of trajectories and chaos indicators.
- Perform FMA studies for BINP CTAU collider project.
- Investigated dynamic aperture optimization by fitting coefficients of nonlinear rotation using NSGA-II.
- Applied machine learning methods for anomaly detection in TbT signals and developed advanced processing techniques for TbT data.
- Developed software for frequency and uncoupled Twiss parameters computation from TbT data along with other related functionality.
- Implemented uncoupled Twiss parameters measurement techniques (from amplitude and phase using multiple triplets) at the VEPP-4M collider.
- Served as an accelerator operator at the BINP.
- Served as a student supervisor.

Jun. 2021 – Current Researcher at Budker INP, Russia

- Developed library for differentiable coupled Twiss parameters computation along with its application examples.
- Developed library for differentiable nonlinear dynamics modeling along with its application examples.
- Implemented RCDS algorithm for online optimization with Bayesian optimization using GPyTorch and BoTorch.
- Leading code development for differentiable accelerator modeling along with an extensive library of examples, developed JAX composable symplectic integrators library.
- Participated in SKIF dynamic aperture studies, analyzed the effects of higher-order multipole errors and insertion devices, and performed high-fidelity FMA simulations.
- Developed methods and conducted measurements of coupled Twiss parameters from TbT signals at the VEPP-4M collider.
- Implemented the square matrix method for nonlinear dynamics analysis.
- Serving as an accelerator operator at the BINP.
- Served as a student supervisor.

Jun. 2022 – Current **Researcher at SKIF, Russia**

- Leading nonlinear dynamics research efforts at SKIF.
- Applied machine learning methods for the localization of linear optics errors.
- Investigating the application of chaos indicators for characterization of bifurcation fractals for 2D symplectic mappings.
- Investigating application of differentiable chaos indicators
- Investigating application of ML techniques to chaos identification.
- Developing generic differentiable accelerator elements modeling library in JAX
- Implemented polynomial perturbation theory with remaider optimization for nonlinear dynamics analysis.

Teaching experience

Jun. 2021 I. Yakimov, Measurement of optical functions at the VEPP-4M (BS)
Jun. 2024 I. Yakimov, Measurement of phase space trajectories at the VEPP-4M (MS)
Jun. 2023 – Current Teaching assistant at NSTU, Russia, NSTU Mini Technology Course

Research skills

Accelerator modeling and optimization, Symplectic integrators, Nonlinear accelerator elements modeling, Nonlinear dynamics, Dynamical systems and stability, Chaos and stability indicators, Nonlinear integrable accelerators, Dynamic aperture optimization, Coupled Twiss parameters, Optics measurements and correction, Application of ML methods in accelerator physics, Differentiable accelerator modeling, Accelerator operation

Computer skills

Intermediate: LaTeX, C, Docker, Haskell, Matlab, MADX & PTC, Elegant, COSY–INFINITY, JAX, Numpy, Numba, SciPy, scikit-learn, GPyTorch, BoTorch

Advanced: Linux, Bash/Zsh, Python, Pytorch, Fortran, Wolfram Mathematica

Honors & awards

- Distinguished Performance Award (7th IASCL, 2012)
- 2nd place at Young Scientist Conference (accelerator section, Budker INP, 2016)
- Oustanding+ Performance at Optimization and Machine Learning course (USPAS, 2021)

Additional social profiles

- MATHEMATICA & Wolfram Language
- YouTube

Selected publications

I. Morozov and E. Levichev, "Dynamical Aperture Control in Accelerator Lattices With Multipole Potentials", CERN Proceedings, 2017

G. Baranov and A. Bogomyagkov and I. Morozov, and S. Sinyatkin and E. Levichev, "Lattice optimization of a fourth-generation synchrotron radiation light source in Novosibirsk", Phys. Rev. Accel. Beams, 2021

I. Morozov and Yu. Maltseva, "Coupled twiss parameters estimation from turn-by-turn data", NIM-A, 2024

T. Zolkin and S. Nagaitsev and I. Morozov and S. Kladov and Y. K. Kim, "Dynamics of McMillan mappings III. Symmetric map with mixed nonlinearity", arXiv:2410.10380, 2024

T. Zolkin, S. Nagaitsev, and I. Morozov. "Dynamics of McMillan mappings I. McMillan multipoles". Physica D: Nonlinear Phenomena, 2025

T. Zolkin and S. Nagaitsev and I. Morozov and S. Kladov and Y. K. Kim, "Isochronous and period-doubling diagrams for symplectic maps of the plane", Chaos, Solitons and Fractals, 2025

T. Zolkin and S. Nagaitsev and I. Morozov and S. Kladov, "Geometry of Almost-Conserved Quantities in Symplectic Maps. Part I: Perturbation Theory", arXiv.2505.07223, 2025

T. Zolkin and S. Nagaitsev and I. Morozov and S. Kladov, "Geometry of Almost-Conserved Quantities in Symplectic Maps. Part II: Recovery of approximate invariant", arXiv.2505.07224, 2025

T. Zolkin and S. Nagaitsev and I. Morozov and S. Kladov, "Geometry of Almost-Conserved Quantities in Symplectic Maps. Part III: Approximate Invariants in Nonlinear Accelerator Systems", arXiv.2505.07225, 2025

Y. Maltseva and I. Morozov. "Aperture limitation localization using beam position and beam loss monitor measurements", NIM-A, 2025